METALS and ALLOYS

The Engineering Magazine of the Metal Industries

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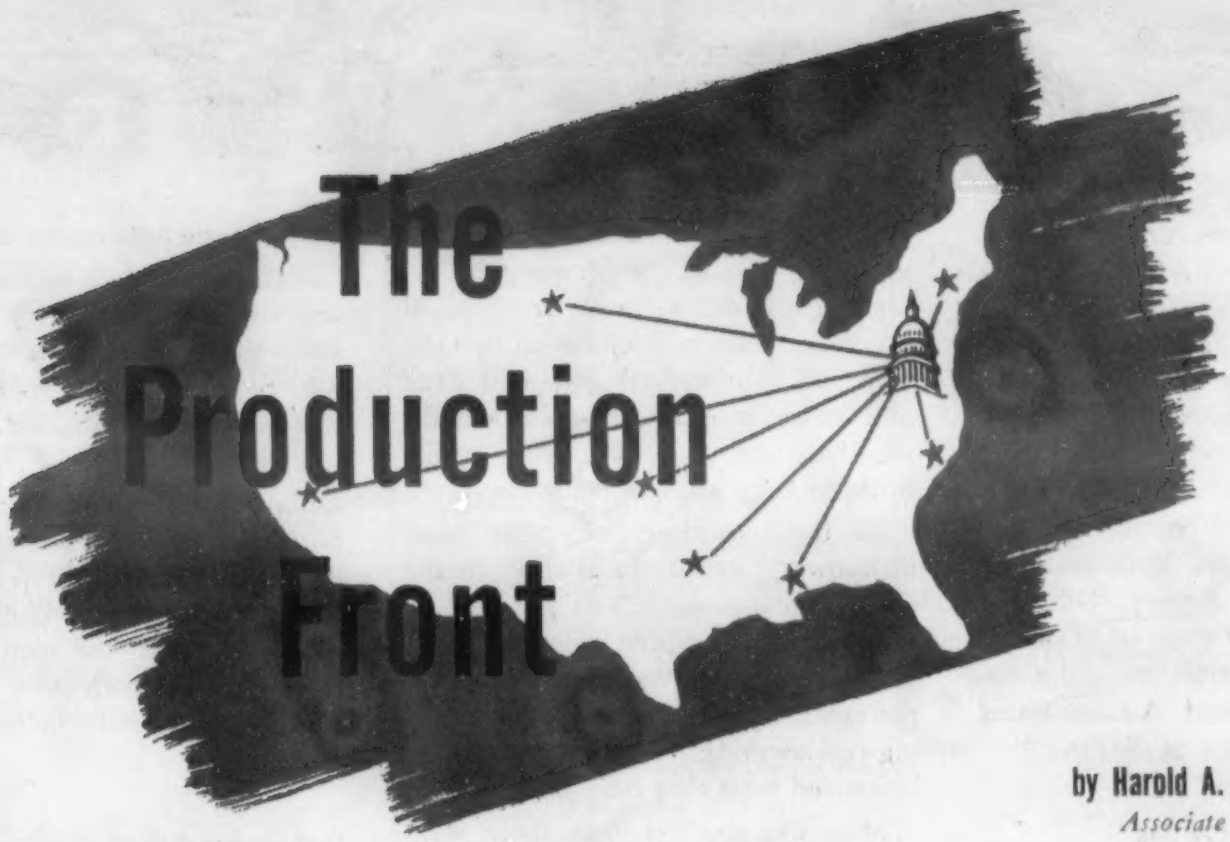
The winged ingot is a symbol of freedom—graphic expression of Dow's recovery of magnesium, lightest of light metals, from sea water to release airplanes from hampering weight. When peace returns this symbol will reach full significance. Millions of pounds of Dow magnesium—also facilities for fabricating Dowmetal castings and wrought products—will speed transportation and lighten innumerable industrial and domestic tasks.

THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

PRODUCER OF THE LIGHTEST OF LIGHT METALS SINCE 1916

MAGNESIUM

INGOT • CASTINGS • FORGINGS • SHEET • STRIP • PLATE • EXTRUSIONS



by Harold A. Knight
Associate Editor

"Logistics" is new in name only. . . . In World War I we measured in thousandths, now ten-thousandths. . . . Bottlenecks passed along to components. . . . Valves critical in April. . . . Six new "claimant agencies." . . . Only 250,000 tons of steel yearly for civilians. . . . Salvage from battlefields 100 per cent. . . . We may put away our tools in late 1943?

Womanpower, now 10 per cent, to go to 30. . . . That German bearing closure. . . . Kanzler served a year to the day. . . . Our 105-mm. howitzer made the "Desert Fox" run. . . . Echoes from our scrap exports to Japan. . . . Steel cartridge cases for ground use only. . . . Choose your jeep or peep for after the war. . . . Silver, the peacock, has gone to war.

Fifty-one production records in face of 33⅓ per cent labor turnover. . . . Light metals become ever cheaper. . . . We throw metal in the form of coin against Hitler.

Logistics and Attrition

To do a logical job of reporting, reflecting and analyzing that fascinating thing called war production, we should follow our products to their non-bitter (we hope) end. But we may have to call in Major George Fielding Elliot, since more and more do our munitions get tangled up with such complexities as logistics and attrition (words not used in the first World War), broad strategy and field tactics as they get into actual service. Our only studies along these lines were Caesar in second-year high school Latin (with the aid of a "pony").

Though many of our military terms are new, what they signify are as old as the sands in Libya. Alexander the Great was a specialist on logistics, the science of supply. Attrition is the wearing down of the enemy faster than you get worn down, and all wars have their striking examples. Caesar was the first blitzkrieger, having set a record for those times of 80 miles in one day — though by himself, not accompanied by his armies. Though many of today's weapons are new, military strategy and tactics are tested and time-worn. Rommel, the desert fox, once visited our own Gettysburg to study Pickett's ill-fated charge and what made it fail.

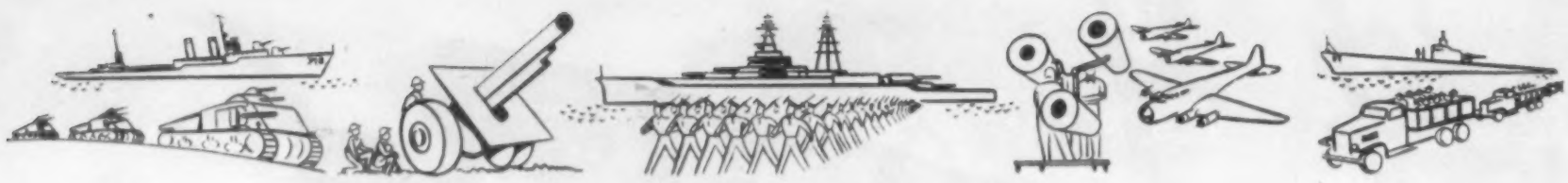
Best Worker is Imaginative

Probably the imaginative worker on one of our military tanks often day dreams as to how this tank will finally perform. Will it be part of some glorious offensive, or will it be half-buried in the ground to serve as a pill box in some desperate defensive operation? We should guess that the imaginative worker is the best worker. He is inspired to coordinate his brain and his hands to turn out the perfect product. During the first World War, the precision of production was in thousandths of an inch — today in tens of thousandths.

But to leave our imaginative tank worker and get down to today's grim facts! Bottlenecks in production are much like a thrombosis or blood clot. The clot lingers a while in one part of a vein, then dislodges and moves farther along. Bottlenecks were first among the raw materials. Now they have moved on to component parts. Donald M. Nelson mentioned both valves and heat exchangers as typical tight components. Thus, valves are common to escort vessels, aviation gasoline and synthetic rubber manufacture, the leading three critical key lines at the moment, to which may be added merchant vessels and airplanes.

"Major Production Crises Are Behind"

Mr. Nelson said that the valve supply situation would become most critical in April, but by June or July the pressure should be off. Speaking generally on materials, Mr. Nelson stated: "Here in early 1943 our real ma-



jor production crises are behind — though we may never be comfortable."

Important has been the establishment of six new "Claimant Agencies," who have the right to demand materials under the Controlled Materials Plan, which goes into full effect July 1. The original four were the Army, Navy, Maritime Commission and Lend-Lease. The six additional are: National Housing Agency, Office of Rubber Director, Office of Defense Transportation, Petroleum Administrator for War, Food Administrator and Facilities Bureau of WPB.

May Not Have Beer to Cry Into

On a par over the worry about bottlenecks in components on the part of Mr. Nelson is the maintenance of public morale. "We've about gone the limit in taking things away from the civilian," he told us. Only 250,000 tons of steel per year (out of 90,000,000 tons of ingots yearly) is available for the civilian, and this almost entirely for the maintenance and repair of existing equipment.

Mr. Nelson worries whether the civilian would still have the will to fight if soft drinks and beer were taken from him. Suppose beauty parlors, barber shops and plumbers were abolished? Yet we feel that the public has more spine than Mr. Nelson gives it credit for. Surely nine out of ten of us realize that under Hitler and his cohorts our present privations would loom as luxuries! The British and Russians are "taking it" — why can't Americans?

Washington no longer seems greatly worried over raw materials, except rubber. There will be enough copper, most all agree. Moreover our salvage from the battlefields is 100 per cent, a top ordnance man says. Lead is still the most plentiful major metal, though Washington has its fingers crossed.

What! Our Production Job Finished?

A rather startling statement from production headquarters is that by the end of this year we will have reached a certain measure of saturation — we'll have all the tanks, planes and guns that we can use for the time being. In short, we will have caught up on the years of preparation by Germany and, henceforth, we will need only to make up losses on battlefields. At that time we may find it difficult to keep all war plants busy.

In the meantime, we need more manpower, which invariably means more womanpower. Ten per cent of war workers are now women. Paul V. McNutt plans to raise this to 30 per cent. Now — and we're not telling you anything — women have revolutionized what they have gone into.

Men first built homes their way. Women finally put pressure on them to get kitchen sinks the correct height to prevent back-breaking. Women drove automobiles and forced easy shift levers and controls. Now women are swooping into war plants and plant owners are simplifying machines, putting in counterweights to make them easier, adding levers in convenient places, often installing seats to take them off their feet. In short, a revolution may now be in progress in industry towards use of less muscle and elimination of fatigue.

Story of "Sisters" and Facilities

All competent observers seem agreed that the fair sex, in their Sally Victor helmets, aprons and slacks, are doing a splendid job and are often pace makers for the men. There is the anecdote about a man who approached a woman: "Sister, you're working too fast — you'll work us out of jobs. Slow down!" "Take that," the infuriated woman shrieked as she struck at her adviser with a wrench. "My husband is at Guadalcanal."

And there's the chuckle about the women and men working in a printing press factory that now turns out fire control instruments. It seems 300 men work in one department and 200 women in an adjoining department. However, the women are forced to traipse through the men's department to reach their "facilities." They retraipse on their return. An efficiency engineer excitedly reported to the management that they'd have to move the conveniences nearer the women.

"The men lose a half-minute gawking when the females pass by —another half minute when they return — 300 production minutes every two or three hours," he insisted.

Plans were made to change the location. But the engineer excitedly burst in upon the management with an uplifted hand. "Stop it," he cried. "I have re-checked. After the women parade through, the men go back to their machines with lusty vigor — the stimulation actually increases production."

That German Bearing Closure

With all our backaches and heartbreaks, are we producing as good quality as our enemies? A high-up ordnance man tells us we have equipment spies "on all waterfronts." As soon as a new gadget is captured from the enemy it is given closest scrutiny. So far, the only real find has been a bearing closure made by the Germans. We are making it now.

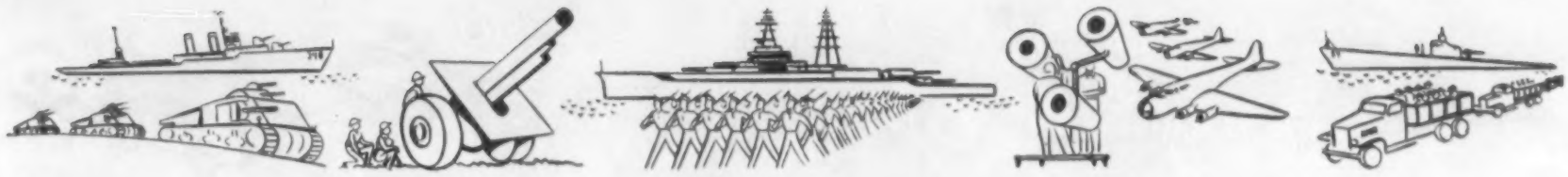
Yes, our military equipment is second to none! He tells us, moreover, that 60 per cent of the ideas submitted for improving quality and speeding production that is sent in by practical men has been adopted by the Army. "Yet they call us brass hats," he laments.

Kanzler Passes in the Washington Parade

Retirement of Ernest Kanzler from the upper stratum of the War Production Board is a sign of the times, close observers of the Washington scene are saying.

How serious was the state of his health as compared with the tough task of making the Controlled Materials Plan work could not be immediately determined, as the war correspondents say. But before he became chief lieutenant to Ferdinand Eberstadt one could see the signs of a rift. After the appointment, betting began in the press room.

Mr. Kanzler, who served just 365 days, has considerable autonomy as chief of the Automotive Branch, which



he moved to Detroit where it belonged all the time.

When he was brought back to Washington by WPB Chairman Donald M. Nelson, he had hopes of putting the proposed CMP on a workable basis. But there has been but little meeting of minds — either on the plan itself or the proposed methods of administering it.

Today, betting in the press room says that CMP won't work without several basic revisions, and the masterminds are against that. It is *their* plan.

"Secret Weapon" in Libya

It apparently can be told now that the "secret weapon" in Libya, which was, perhaps the chief factor in driving Rommel from Egypt, was the M-7, a 105-mm. howitzer mounted on a tank chassis, with an anti-aircraft gun offering some protection against overhead attack.

The gun can hit objectives seven miles away and, with its crew of four, can travel at 35 miles per hour. It has been called the most powerful weapon of its kind in the world and easily neutralized the former desert-supreme German 88-mm. guns.

Since last June, more than 10,000 workers at the Schenectady plant of the American Locomotive Co. have kept the secret of this mystery weapon.

Scrap and Big Pig Iron Program

Here's a new slant on the scrap steel exported to Japan for several years before Pearl Harbor. "Would it have been necessary to build fully 20,000,000 tons of new pig iron capacity if the millions of tons of scrap exported before the war had been available as a reservoir?" This question was asked by Robert W. Wolcott, president, Lukens Steel Co., and head of the scrap committee of the American Iron and Steel Institute, of members of the Scrap Iron and Steel Institute, Inc. at their fifteenth annual convention at New York.

Mr. Wolcott is a man who can truthfully say: "I told you so." Some half dozen years ago he headed an organization that tried to persuade the Government to limit steel scrap exports. In view of the facts revealed in the "White Book," it would seem that the Government had enough facts on international goings-on to have met Mr. Wolcott at least half-way at that time.

Peacock Metals Go to War

There's an old saying: "A peacock may have the feathers, but it takes the stork to deliver the goods." Through the ages, silver and gold have been much the peacocks, made into jewelry, hoarded as monetary assets, and, all in all, the pretty metals.

But, like the dainty miss who has gone into a war plant, so has silver — and gold may follow. In 1942 the arts and industries in the United States and Canada used 119,000,000 oz. of silver, an increase of nearly 50 per cent over 1941. "Nearly 60 per cent of that used in the United States went into war production," states Handy & Harman.

How can gold be put to work in war industries? That is what the Board of Economic Warfare wants to know, and has started a survey along those lines. Gold has corrosion resistance, high strength, ease of soldering or welding, and can be rolled, stamped, spun or drawn.

So, reader, if you have ideas about how gold can shoulder arms, write us — we'll pass them along.

Steel Cartridge Cases Again

There's a chap in Army Ordnance, who wears plenty of stripes, stars and insignia, who doesn't want to be quoted, but who told us that it is the Army's intent to use steel cartridge cases only on the ground.

One can imagine the plight of the gunner in the airplane whose gun would jam because he was not able to eject the spent gilded steel case. On the ground, the soldier has more time to eject the stubborn empty case or grab another gun and, perhaps, some brass cases.

After War: Jeeps, Peeps, or What?

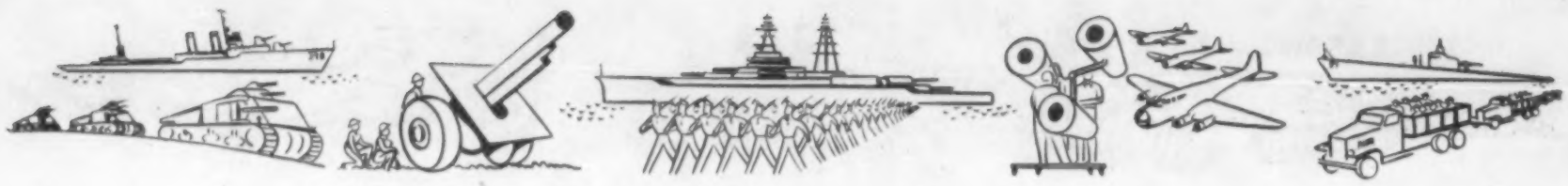
You don't hear much about formal plans for post-war automobiles in Detroit, but more and more engineers, with the pressure on retooling and redesigning armament products relieved, are beginning to have hunches on the car of the future.

A consensus of lobby, cocktail lounge, and after-hours opinion shapes up like this: If the war is long, look for something ultra. Many body dies and most machinery have been rebuilt, scrapped, or melted, and more will disappear if the war is protracted. Companies then will have a clearer choice of going "all out" on design, or attempt a commercial comeback with considerable changes.

If the war is short, much of the manufacturing equipment will still be around, and most of the companies will pick up about where they left off. Some will undoubtedly bring out rather conservative models, but most of this group will have something different if they believe that there will be a market for the ultra.

Large capacity for aviation grade gasoline will speed the trend toward smaller engines. New, small, compact and efficient air-cooled engines will be developed from the present aircraft experience. Huge increases in the nation's aluminum, magnesium, and alloy steel capacities will influence design. Plastics and plywoods are almost taken for granted for many parts, including low-stress structural sections. Cars will be lighter.

Status of post-war economics will go far to determine price. Some high-placed engineers expect that a modern version of the Model T Ford will predominate the market, which will demand a utility vehicle at low cost.



Some expressed their convictions that the jeep will be redesigned and polished up for retail trade. Combat experience, and the subsequent design changes, will have eliminated the "bugs" and given this type of car a preferred place.

More people are talking about William B. Stout's "Scarab," still by far the most comfortable car your correspondent has ever driven or been driven in, handles the best, and has many design elements of the "car of the future" category.

Fewer engineers than economists are interested in whether the automobile industry will "take over" the aircraft industry, or *vice versa*. Certainly there will be more aircraft companies than ever before, whether they include Ford's, G.M.'s or Chrysler's nameplates or not.

Best estimates indicate that production engineers think they could retool for automobile production in less than half the time it took to tool up to produce the unknowns: tanks, guns, airplane sub-assemblies, aircraft engines and parts, accessories, and the other tools of war.

Most engineers agree on this point: Everyone will know more about metals and other materials than they ever knew before. A number expect that there will be new names in the automobile business, such as Henry J. Kaiser (dams to ships to steel, to aircraft), and General Electric.

Conservation and Salvage Divisions

With the resignation early in January (effective February 1st) of Lessing J. Rosenwald as director of WPB's Conservation Division, two new divisions were created by Donald M. Nelson to handle the conservation and salvage programs of the war effort. Both the Conservation and Salvage Divisions will report to Curtis E. Calder, utility and investment executive.

Howard Coonley is the new director of the Conservation & Substitution Division, which has three technical branches, and Paul C. Cabot is director of the Salvage Division. Both were Mr. Rosenwald's deputy directors.

Hear That Clang of Metal?

That's One Hundred Billion Dollars

by V. M. McConnell

Stop and listen,
Hirohito,
You and Adolf
and Benito.
Does that clang
Of Yankee metal
Sound disquieting
To thugs?
It's that hundred
Billion smackers
Being spent
To smack attackers,
To eradicate
Their rackets,
And erase
Their homely mugs.

Conservation Division

Conservation & Substitution Branch, Harvey A. Anderson, chief: A veteran of nearly three years in war work in Washington, Mr. Anderson is also Mr. Coonley's deputy director of the division.

Simplification Branch, headed by Robert A. Shepard, with A. M. Houser as assistant.

Specifications Branch, under C. Laurence Warwick, erstwhile secretary of the American Society for Testing Materials. Blodgett Sage is his deputy.

The Conservation Division consists of more than 100 technically-trained specialists who serve various industry divisions of WPB and other government agencies. Mr. Coonley was chairman of the Walworth Co., is a past president of the National Association of Manufacturers, and the American Standards Association.

Salvage Division

These branches, with their respective chiefs, serve under Mr. Cabot:

Scrap Processors' Branch, Merrill Stubbs, chief: The former auto graveyard program is a part of this branch.

Special Projects Branch, headed by Andrew Yinkley, Jr.

Industrial Salvage Branch, the chief of which is Hamilton W. Wright. Under this branch has been organized a Technical Service Section, designed to solve all technical salvage problems in the field. H. M. Barr is acting chief.

General Salvage Branch, with W. Richard Talbot its acting chief.

Production Records Despite Handicaps

Our war production is particularly remarkable when one considers all the handicaps constantly encountered. Typical is the case of the Inland Steel Co., Chicago.

In 1942 it accomplished a total of 51 production records in its Indiana Harbor plant — in the face of a 33⅓ per cent labor turnover and a 40 to 50 per cent replacement of personnel in its general offices. In 1942 alone, 1,360 workers left the Indiana Harbor plant for the armed services.

Light Metals Prices Decline

In the post-war scramble and competition of materials, prices will again be an important element in the decision of the materials and design engineer, a topic which is apropos because the price of pure magnesium has just been reduced 2 cents per pound — to 20½ cents.

When Dow Chemical Co. started producing that metal in 1915, magnesium sold at $3.50 per pound. Also striking is the price history of aluminum, which now sells at 14 to 15 cents, the cheapest in its history. Copper, which now sells at 12 cents, may particularly find competition with aluminum severe.

Less Paper for Your Publications

During the first week in January the War Production Board issued Order No. L-244, which limits the amount of printing paper that a publisher may use in 1943 to 90 per cent of his consumption in 1942. In the case of METALS AND ALLOYS the actual curtailment must be much more than 10 per cent, since commitments had been made that would expand the wartime service and volume of the magazine to a level considerably *above* last year's.

Several steps have been taken to effect this curtailment without sacrifice of our basic editorial service and volume. In company with many other industrial magazines we have with this issue reduced our overall dimensions (as you perhaps have already noted) to 8⅛ in. by 11¼ in., have employed a somewhat lighter paper stock and have made other mechanical changes to decrease our paper consumption. But we can promise our readers that there will be no net reduction in the quantity of editorial material until all other expedients—including an ultimately possible limitation on the number of advertising pages in each issue—have been applied.

Technical publications are now included in the WMC's list of essential industries. The information service they are providing can be of critical value in our war production effort. METALS AND ALLOYS pledges that this editorial service shall not be curtailed so long as other answers can still be found to our paper shortage problem.

—The Editors

A Broadened Wartime Reader-Service

The demands on an engineering magazine in time of war mount rapidly. Readers need a continually increasing flow of technical data on materials and their processing; engineering departments are short-handed and both they and their production-line colleagues depend ever

Better Steels Are Coming— from the Tests of War

Out of today's grueling war tests are coming better steels for tomorrow. In Britain, Russia, North Africa, and the Far East equipment built of American steel is setting new performance and endurance records.

But, we have not yet come to the end, for world-wide battle tests are pointing the way to new requirements that are being met in the laboratories and the steel mills of America.

Inland is actively taking its place in this new phase of the steel age. Before World War II Inland gave to industry such valuable steel mill products as: high-strength Hi-Steel; fast machining Ledloy; finer cold reduced tin plate; etc.

Today, with greatly enlarged research facilities and the valuable experience of exacting wartime production, Inland is looking forward to meeting the steel needs of America at peace.

INLAND STEEL CO.

38 S. Dearborn Street, Chicago • Sales Offices: Milwaukee, Detroit, St. Paul, St. Louis, Kansas City, Cincinnati, New Yo

more heavily on industrial magazines for much of their vital design and operating information. Under these circumstances, a responsible industrial magazine today has an actual *obligation* to expand its facilities for providing war production engineering information, if it can possibly do so.

For this purpose, METALS AND ALLOYS has just added to its staff a new associate editor, Robert S. Burpo, Jr., formerly methods engineer and materials engineer with the Grinding Machine Division of Norton Company, Worcester, Mass. Mr. Burpo, a graduate of American International College and Massachusetts State College, was employed by Westinghouse as process inspector at the East Springfield plant before joining Norton Company in 1939.

His responsibilities on our staff will include the preparation of articles and reference data — tabular and otherwise — on materials and their engineering properties; on processing methods and equipment; on basic metal-industries engineering principles; and on applications of various products. Most of this information will be published, although some will be available for private distribution only.

Mr. Burpo, in his steps to make these job-useful facts and data available to thousands of war-production engineers through our pages, will need all the help experienced and authoritative engineers and organizations in the field can give him. We are sure he will receive their full cooperation. —The Editors

The Hereafter—
A Sermon for Sunday Afternoon

On Sunday mornings throughout America a large part of our people still goes to church, deriving therefrom a certain amount of inspiration, comfort or, occasionally, sleep. For most of these, Sunday morning is the time for consideration of "the hereafter" and the individual's probable place in the hazily visible world-to-come.

But, whatever he does on Sunday morning, there is another hereafter that should henceforth become the American engineering executive's chief Sunday *afternoon* preoccupation — the industrial hereafter that will inevitably follow this period of war. For all of us as a group, this sequel can be a Heaven of maximum employment of men and money to make more goods of better quality, and sold at lower prices than ever before; or it can be a Hell of unemployment, vanishing purchasing power, idle or confiscated capital and stagnant industrial progress. What it is most likely to be, unless we — as a people, as Industry, and as engineers — give the subject every possible moment of attention, is a painful Purgatory of restricted employment and made-work, heavy Government regulation, nervous capital and a minimum of goods for general distribution.

In the months to come we will preach often of this hereafter — not because we think the war is nearly over; we personally expect at least 2 years more to pass before the end will be even in sight — and not because we underestimate the primary importance of *winning* the war first; victory will be hard-earned, and we would class as criminal the allocation to any other purpose of time or equipment that belongs to the war effort. But in even the busiest personal wartime schedule there are one or two hours in every week — if not on Sunday afternoon, then at lunchtime or just before dinner or after crawling into bed — that can *with profit to your country* be devoted to pondering the problems of the industrial hereafter.

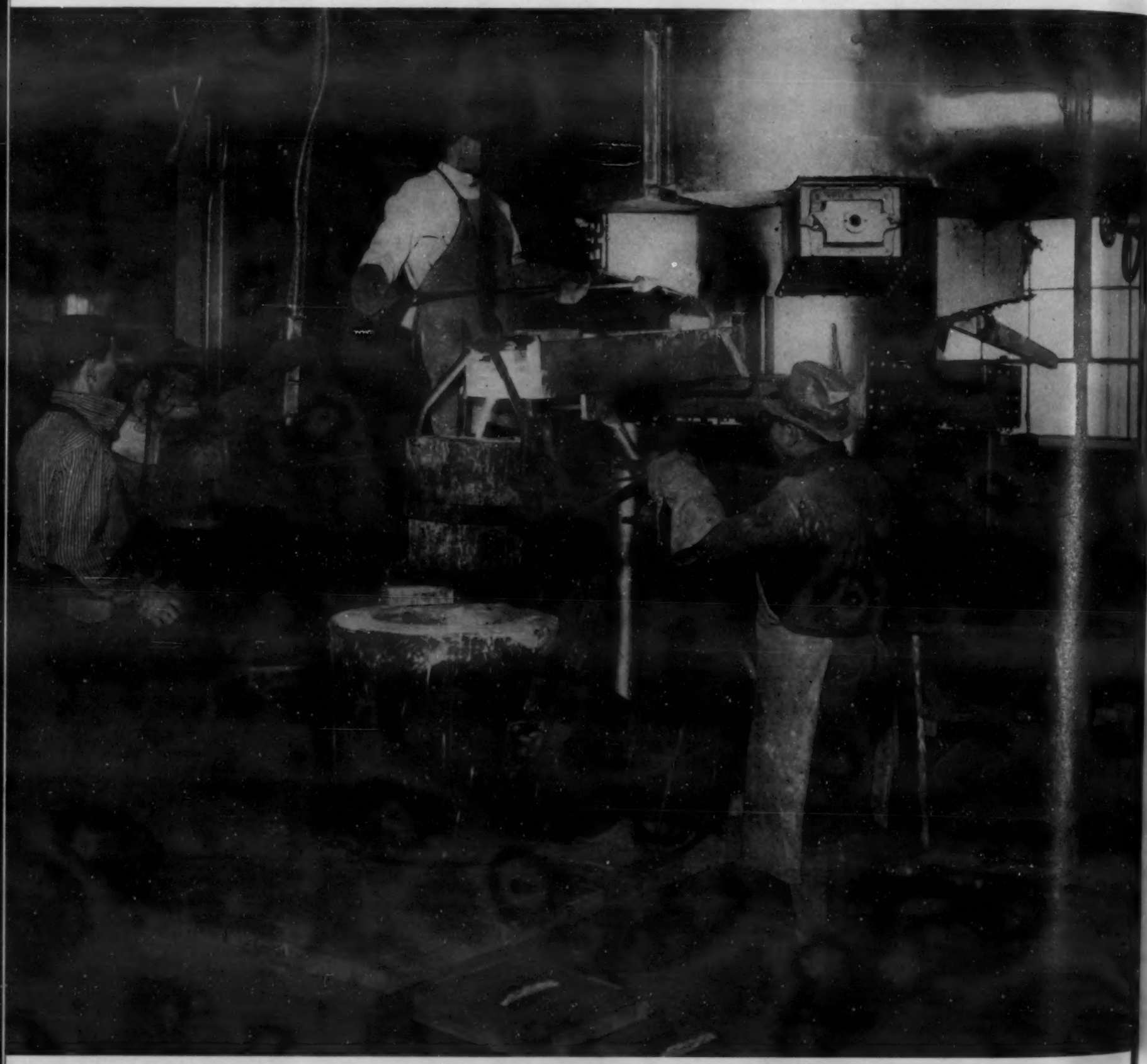
Brethren, it is for this hereafter that we are fighting today's war! What eternal fools

(Editorial continued on page 344)

Cupola Melting of Loose Cast Iron Borings

by S. L. Feduska

Research Metallurgist, United Engineering and Foundry Co., Canton, Ohio



A modern cupola with the latest gadgets being used for development work by the International Nickel Co., Bayonne, N. J. (Courtesy: Int. Nickel Co.)

The need for complete utilization of metallics, both for the iron content and the alloy content, in cast iron borings, steel turnings and malleable iron turnings, is vital to winning the war. Up to the present time, American industry has failed to solve this scrap problem. The idea of melting loose turnings in the cupola will raise serious doubts as to its practicability in the minds of cupola operators, but cupolas have actually been operated on scrap that is even less desirable than turnings in some of the sash, counterweight and ship-ballast producing foundries. The problem is not so much a melting problem as one of achieving a quality end product. A satisfactory solution to the scrap problem will not be forthcoming until every type of ferrous melting furnace in both foundry and steel mill utilizes scrap in the form of borings and turnings to at least 10 per cent of the weight of the furnace charge.

A cupola authority who reviewed this article believes that a small-sized fuel would offer much greater opportunity for success in direct melting of borings than the run of oven-sized foundry coke. That is, very small fuel particles (probably not over 2 in.) would be called for. It is possible that smaller units of fuel and metal would also increase the practicability of the idea.

And now, what malleable *foundry, using the duplexing process, has or will work out a method of adding malleable iron turnings to the metal stream flowing between cupola and air furnace (or electric furnace)? This industry is melting about 2,000,000 tons of metal per year and with a little ingenuity could utilize some 50,000 tons or more of malleable iron turnings.*

We have heard a great deal about "substitution" and "ersatz" materials in this war but we feel that complete utilization of iron and steel raw materials and processing facilities is most important. Iron foundries and steel plants alike should be indebted to Mr. Feduska and to his superior, Mr. John Quinn, manager of United's Canton plant, for these details of their work. —*The Editors*

THERE ARE ABOUT 2800 iron foundries in this country that have the problem of disposing of iron borings. Some of the larger machine shops produce thousands of tons of cast iron borings per year while a number of the smaller shops produce only a few hundred tons in a year.

Until the present shortage of almost all types of scrap developed, each producer had its own particular means for the disposal of iron borings. The disposal is a nuisance problem to most foundries; the easiest solution apparently is the miscellaneous accumulation and sale of the borings to a scrap dealer who in turn sells them for melting in a blast furnace.

The shortage of scrap has redoubled the efforts of iron foundries to use the borings produced from their own castings. A number of methods have been suggested in an attempt to convert the iron borings to some usable condition. Briquetting produces a product suitable for charging into the cupola, and this method for reclaiming iron borings is the accepted one among large producers.

Some large producers have completely equipped salvage plants for the briquetting of both iron borings and steel turnings. However, the average borings producer does not accumulate sufficient tonnage to justify the expense of installing and maintaining even a small briquetting plant. The average iron borings producer consequently had to be content with trying a number of methods for the recovery of scrap that did not involve any major expense or require the purchase of extensive new equipment.

One of these methods suggested that the iron borings may be placed loosely or compressed into steel containers or cans, the container and contents being charged into the cupola. The steel containers were used as a protection for the borings during melting. In another method Portland cement was used as a binder for compressed or loose iron borings. A unique method suggested the pouring of liquid cupola metal on the iron borings and then rotating the aggregate in order to produce a coherent mixture of iron and borings that could be directly charged into the cupola.

The Problem

The development of a method for the melting of loose cast iron borings by charging directly into the cupola was due to the need of a particular type of iron scrap at our plant. Early in 1941 an urgent need arose for a certain class of chromium-molybdenum-iron scrap, low in phosphorus. Instead of returning worn-out rolls to be used as scrap in making new rolls of the same type, some users of rolls were melting these scrap rolls in their own open-hearth furnaces. The result was a shortage of this class of iron scrap at our plant and necessitated the use of more and more virgin materials in making these roll heats. More low-phosphorus pig iron had to be used, which in turn had to have its carbon content reduced by the use of more steel and, finally, the chromium and molybdenum content had to be built up by the use of larger amounts of alloys.

A survey was made of the scrap conditions at our plant. This survey showed that one source of available scrap of this type was in the salvage of the roll turnings produced. These together with other types of roll turnings, at that time, were being ac-

cumulated in carload lots for sale to a scrap dealer and eventually were remelted in a blast furnace, thereby losing all contained alloys.

Another attractive feature that spurred interest in the salvage of these turnings from a cost viewpoint, was that roll scrap of this type cost $27.25 per ton, while roll turnings of this type sold for only $15.25 per ton. Thus it was observed that beside producing a desirable class of scrap through the salvage of these roll turnings, an attractive margin of $12.00 per ton was available to defray the cost of the salvage operation. On other grades of roll turnings, a margin of $8.25 per ton was available to offset the salvage cost—this value did not include a potential $5.25 per ton salvage of contained critical alloys.

The amount of these iron borings produced at our plant, as in the case of the majority of foundries, probably is not sufficient to justify any major expenditure for the installation of briquetting or other salvaging equipment. It was decided to find out whether the iron borings could be recovered with our available equipment.

In our case, the available equipment consisted of one hand charged 45-in. cupola. The direct melting of the loose iron borings was decided to be the logical beginning for our experiments. If the loose borings could be successfully melted by directly charging into the cupola, this would be the most economical method for converting them to a usable form. If direct melting was possible, briquetting and other methods of processing for melting would be superfluous and would only add to the total cost.

In our first tests we collected borings of the special low-phosphorus roll grade. The borings were accumulated in large containers prior to delivery to the cupola charging floor. The accumulated turnings consisted of a mixture ranging from very fine hairlike particles turned from the chill-cast roll bodies to larger turnings obtained from deep roughing cuts on the softer sand-cast roll necks. The density of the turnings varied from 35 to 95 lbs. per cu. ft.

Operating Tests with Loose Borings

A number of tests were made on the direct cupola melting of the loose borings. The ultimate aim of the tests was to determine if the direct cupola melting of loose iron borings was possible with a normal metal loss at a satisfactory melting rate.

The actual experiments consisted in varying the charge size, wind box pressure and stock height. The amount of turnings melted varied from 2,000 to 14,000 lbs. per day. The first two tests, consisting of single melts of 4,000 and 2,000 lbs., were made at the end of a daily cupola run. The purpose of these first tests was to determine whether the turnings could be melted without going "up the stack."

In these first tests a low wind box pressure was used; in succeeding tests the pressure was gradually increased to that used in melting a normal iron charge. After these first two tests the purpose of the next tests was to continuously melt larger amounts of iron borings. In the first attempt to melt continuously 14,000 lbs. of turnings some difficulty was experienced in melting the turnings; observation showed that a normal blast had difficulty in penetrating the stock charge, requiring a tremendous increase in blast pressure.

The solution to this problem obviously was to decrease the charge size and also decrease the stock height. The effect of these changes in stock heights and charge sizes resulted in an improvement of melting rate so that we were able to continuously melt at normal blast pressures without difficulty. In succeeding tests the melting rate was gradually improved, and it is believed that continuous melting rates equal to the 8 ton per hr. capacity of our 45-in. cupola may be obtained.

The Best Practice

Our best practice was to melt with a blast pressure of 6 to 10 oz., maintaining a stock height of 4½ to 5½ ft., having charges consisting of 1500 to 2000 lbs. turnings, 150 to 200 lbs. coke, and 35 lbs. limestone.

The amount of metal lost was less than 5 per cent, this value being determined by finding the difference between the weighed charged turnings and the resulting pigged iron. The metalloid losses on melting the turnings of an iron having the following approximate analysis: T.C. 3.14, Si 1.09, Mn 0.44, Cr 0.82, Mo 0.35 per cent was as follows: Cr 25, Si 25, Mn 50, Mo 25 per cent. In one case only the carbon content dropped to 2.56 per cent.

In our best continuously melted heats of about 5 tons, the carbon ran higher than those of the charged turnings. While the turnings had a carbon content of about 3.14 per cent, the carbon contents of continuously melted turnings heats ran 3.30 to 3.60 per cent, indicating that some carbon had been absorbed from the coke.

Even under our best practice in these tests the volume of slag formed appeared to be more than that obtained from cupola melts of the same size. However, on closer examination, the slag was observed to have a very low density compared to usual cupola slag obtained from regular iron melts. The slag, apparently, was of such fluid nature that it was aerated to a foamy mass upon leaving the slag hole.

Examination of the cupola lining after each test showed that slightly more than usual erosion of the lining occurred in a few early tests. However, later tests did not show any more lining erosion than that expected in melting regular iron heats of the same size. In any case the amount of lining erosion, even

under the worst melting conditions, would not be considered excessive.

[Although metal temperatures are not mentioned, the reader can assume that they would be normal for the type of furnace, or between 2600 and 2850 deg. F.—Editors' Note.]

How the English Do It

After our tests had been completed, a private communication was received from England describing the direct cupola melting of loose gray iron borings. A process for the direct cupola melting of these borings, similar to our process described above, has been practiced for the past 4 yrs. by an English foundry. In their practice, the loose borings are charged directly into the cupola. At the present time 6 to 7 tons of loose iron borings are being continuously melted each day in a 33-in. diameter spare "balanced blast cupola."

The coke bed was kindled and built up in the usual way. Two charges, consisting of 500 lbs. of cast iron scrap, were placed on the top of the coke bed and blast put on. The level of the stock in the furnace was maintained by charges made up of 400 lbs. loose iron borings, 200 lbs. pig iron or scrap, 100 lbs. coke, 75 lbs. limestone, and 50 lbs. silica sand.

The height of the stock inside the furnace was found to be of great importance because, if the stock line was too high, the blast was unable to penetrate and the cupola eventually stopped melting. A stock height of 5 ft. and lower gave the best results, and the charging was such to maintain this height. The highest pressure, about 20 in. water, of which the fan was capable was used. The melting rate was about one-third normal and an output of 1¼ tons per hr. was obtained from the 33-in. diameter furnace.

The limestone addition in the English practice was considerably heavier than that used with normal cast iron charges. The silica sand was added to neutralize the large lime addition. The object was to obtain a large body of slag to dilute the iron oxide produced from the borings. The weight of the slag produced was about 22 per cent of the weight of the metal melted. The total iron loss was found to be less than 3 per cent. The lining erosion, although more than would be obtained in melting normal iron charges, cannot be considered excessive. At the present time all metal produced from melting the charges containing loose iron borings are poured into pigs. The typical analysis of the iron produced was as follows: T.C. 2.3, Si 0.80, Mn 0.25 and S 0.15 per cent.

Using a 45-in. diameter instead of a 33-in. diameter cupola a melting rate of 6 tons of borings per hour was obtained; however, the charge consisted of 800 lbs. borings and 400 lbs. pig iron or scrap. The process, as now practiced by this English foundry, runs continuously for a normal cupola melt of 3 hrs. or longer if desired and handles all the borings produced in the shop, about 100 tons of iron borings and 30 tons of steel borings per month.

Some Practical Comments

In general, a number of different procedures may be suggested for using loose iron borings melted in a cupola. The first is the melting of 100 per cent borings and pouring directly into castings after building up the small metalloid loss. This is probably the most economical method for using gray iron borings. This method may be varied to incorporate that percentage of borings in the charge to exhaust the supply of borings at the same rate that it is produced in the shop.

Some foundries, making a large number of special alloys, may find that it is more convenient to pig the turnings and use them in subsequent heats.

Starting with a base rate of $15.25 per ton for iron borings and adding $5.50 per ton as the probable cost of cupola melting, results in a total cost of $19.75 per ton of loose iron borings melted. Today the average foundry would have to pay about $24 per ton for scrap and about $25.50 per ton for pig iron delivered at its plant. It is observed that a saving of $3.25 to $4.75 per ton may be realized through the melting of loose iron borings in the cupola and casting into pigs for use in subsequent heats. If the iron borings are used as part of a charge for pouring castings directly, a saving of $8.75 to $10.25 per ton is possible.

Besides making synthetic pig iron or foundry scrap, cupola melting of loose iron borings and steel turnings may be used in a process for making synthetic steel scrap. The procedure may be as follows: Melt the loose turnings in the cupola, desulphurize in the forehearth, accumulate in a mixer, reduce the carbon and metalloids in a Bessemer converter, dephosphorize in the ladle. Using this procedure it is believed that a large producer of iron borings and steel turnings may make synthetic steel scrap at a cost lower than that of steel scrap purchased on the market.

To summarize, therefore, a method for direct cupola melting of loose iron borings has been described whereby the average iron foundry may melt all the iron borings produced in its plant. The direct cupola melting of loose iron borings makes possible the use of low cost raw material in place of more expensive and scarce scrap. The average foundry may possibly directly melt loose iron borings and steel turnings with its present equipment—this is of special importance at this time since the materials and labor used in making new equipment is not diverted from a more direct production of war equipment.

One engineering topic on which little published information exists, despite its basic importance in these days of "mineral warfare," is the metallurgy, design and manufacture of steel mining-drills. American readers therefore will find much that is new, interesting and helpful in Mr. Simons' review of the steels and production methods used in England to make hollow mining drills. Two processes—a metal-core method and a technique of casting the steel around a tube before rolling—are currently favored.
—The Editors.

Making Hollow Steel Drills

by ERIC N. SIMONS

Orchard Bank, Sheffield, England

THERE ARE NO FEWER than five different methods of producing hollow mining steel drills with a suitable hole. All these methods are used by British makers, but the first two are virtually obsolete, and have been replaced in almost all works by more up-to-date methods. The five processes are as follows:

(1) Rolling on a mandrel core.
(2) Rolling on a sand core.
(3) Rolling on a copper core.
(4) Rolling on a metal core.
(5) Casting around a tube before rolling.

The analysis to which the best British drill steel manufacturers regularly work is as follows: Carbon as required; silicon 0.2 per cent, sulphur and phosphorus combined 0.04 max., Mn 0.4 per cent max. In most instances, however, the impurities fall below these figures, and to illustrate this, the analysis of an actual cast, taken at random, is given below:

Carbon 0.64, silicon 0.174, sulphur 0.014, phosphorus 0.011, manganese 0.28 per cent.

There is a marked diversity of opinion among mining engineers about the most desirable percentage of carbon for mining drill steel, but it is generally accepted that a steel containing 0.62 to 0.68 per cent C is satisfactory for the softer rock, while 0.72 to 0.78 per cent will give better drilling efficiency when operating on hard rock.

Certain mines have used an 0.9 per cent C steel drill, but greater skill is necessary to forge and harden steel with the higher carbon content, and where mining conditions are rough and labor primitive, the results have not always been satisfactory.

To provide a choice of carbon content, British makers standardize on three tempers: (1) 0.62 to 0.68 per cent C; (2) 0.72 to 0.78 per cent C; (3) 0.87 to 0.93 per cent C. Special casts are, however, made to suit requirements outside these limits.

Properties Desired

Heavy punishment is inflicted on drill steel by the powerful percussion tools, and one of its most important properties must be a high fatigue resistance. Coarse-grained steel is much more susceptible to failure from fatigue than fine-grained steel, and as the main body of the drill is put into service without any form of heat treatment, the steel must have a fine grain structure.

British mining-drill steel makers concentrate in the first place on this aspect—the production of drill steel with an extremely fine grain. Most drill steel compositions lie within the range 0.6 and 0.9 per cent C. A brief, elementary review of the changes that occur when such steels are heated and cooled will show the relation between British practice and the grain sizes obtained. Above the line A-C in the iron-iron carbide equilibrium diagram, the only constituent is austenite, but as the temperature falls, decomposition begins when the line A-C is reached, and the solid solution austenite begins to deposit iron.

This precipitation of iron continues as the temperature falls, and the remaining austenite becomes richer in carbon until the line at 695 deg. C. (1280 deg. F.) is reached, when it changes to pearlite. Therefore, below 695 deg. C. (1280 deg. F.) no further changes take place, and the constituents present in the drill steel are ferrite and pearlite. These may be observed in Fig. 1, the white constituent being ferrite and the dark, laminated structure, pearlite.

A reversal of these changes takes place when the steel is heated, but the change points occur about 30 to 35 per cent higher than when cooling. The changes on heating are shown by the dotted line on the steel diagram (see Fig. 2). Although the steel, when heated within the austenite area (Fig. 3), will consist of austenite, the size of the austenite grains changes. As the temperature is raised above the line A-C, the grain size is rapidly increased. Obviously, therefore, the material must not be taken to high temperatures.

Rolling and Forging

Coarse grain in steel can be refined by rolling or hammering, which breaks up the coarse grains into smaller ones; but when work is finished above the line A-C, the grains will grow again until the material has passed from the austenitic zone. Consequently, the initial forging temperature must be regulated, but more important still, the temperature at which the work is finished must be controlled, so that the work ceases as near the line A-C as possible. This done, the steel quickly passes through the change points on the line A-C and the line 695 deg. C. (1280 deg. F.) and danger of grain growth is eliminated.

If the material is rolled or forged below the line A-C, cold work is put upon it, and to continue work below the 695 deg. C. (1280 deg. F.) line will result in distortion of structure, leaving a strained and unsatisfactory condition. Rolling on the best British drill steels is, therefore, carried out within the range 1100 to 700 deg. C. (2000 to 1300 deg. F.)

The hollow drill steel passes through the rolls for the last time at a temperature as near 700 deg. C. (1300 deg. F.) as possible. Thus, work is completed very near the change point, and in consequence the steel has a homogeneous and fine structure, while there is no fear of crystal distortion due to cold work. Figs. 1 and 4 are microsections, showing a transverse and longitudinal section taken on material in the "as-rolled" condition. Each displays a homogeneous structure showing no signs of crystal deformation due to cold work.

Fig. 5 is a photograph of a fracture from a bar of British drill steel in the "as rolled" condition with, for purposes of comparison, a fracture of a European drill steel. The difference is apparent at a glance. The photographs are at 2 magnifications.

The Mandrel Core Process

Of the five British drill-making methods, the first—the mandrel core method—was originally a Swedish process. A hole is drilled in the billet, which is heated up for rolling. Before rolling is

Fig. 1. Micrograph of drill steel in the as-rolled condition; longitudinal section. 500X.

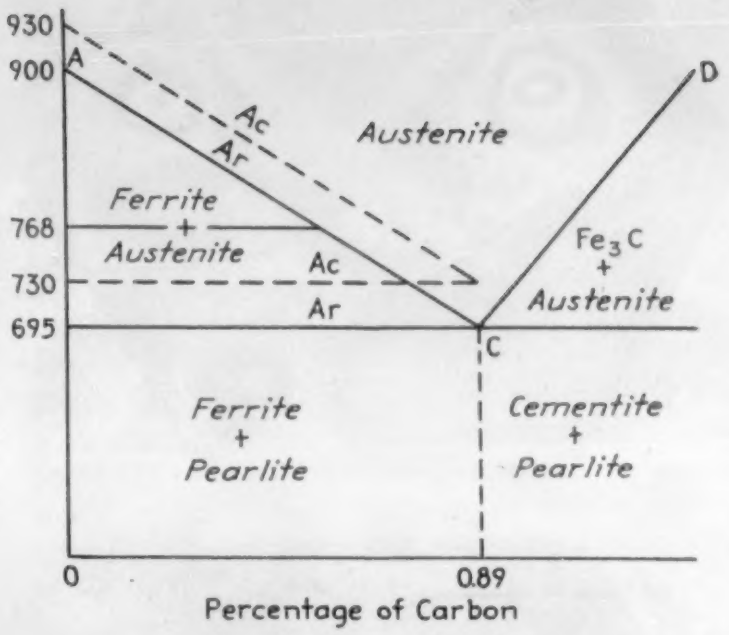


Fig. 2. Panel of equilibrium diagram, iron-iron carbide system. (Courtesy: Blackie & Son, Ltd.)

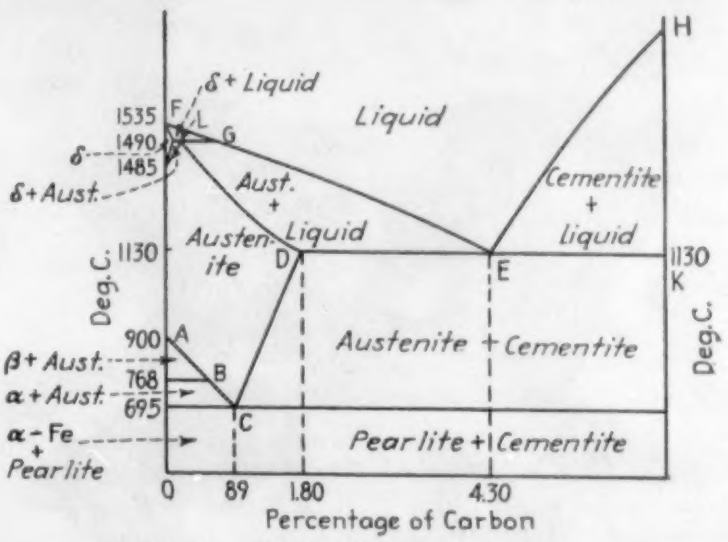
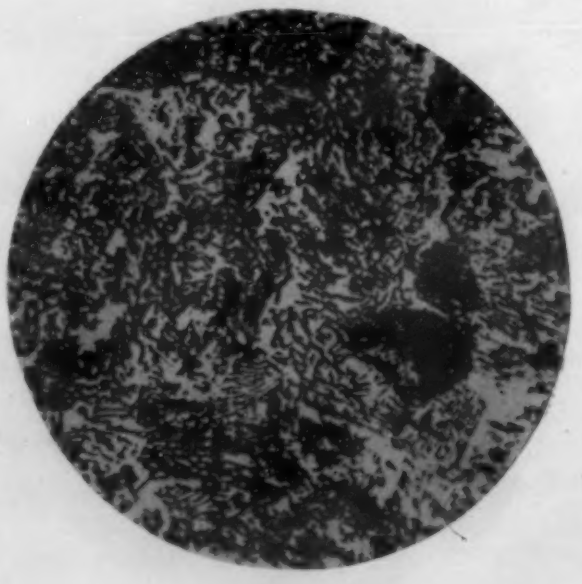


Fig. 3. Equilibrium diagram, iron-iron carbide system. (Courtesy: Blackie & Son, Ltd.)

Fig. 4. As-rolled drill steel, transverse section. 500X.



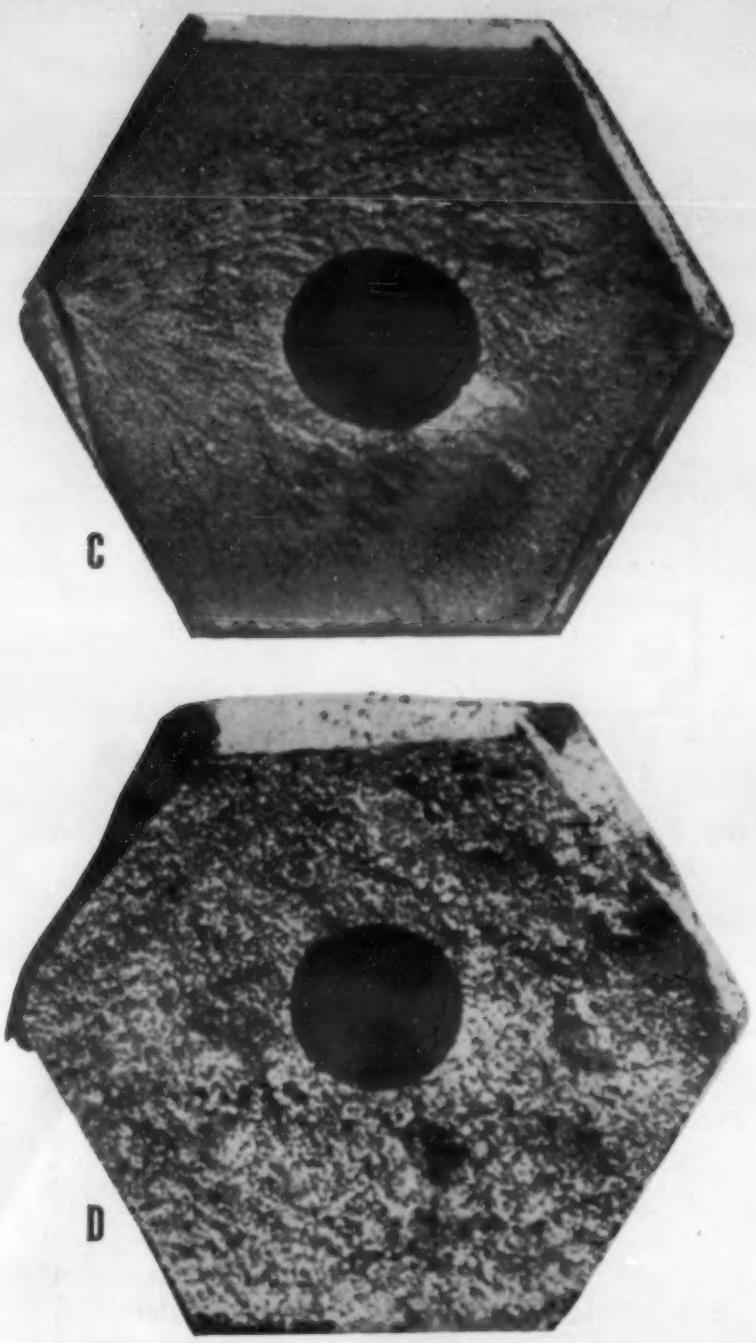


Fig. 5. An illustration of the effect of rolling temperature on grain size. C is a British hollow drill steel. D is a European hollow drill steel.

begun, a cold circular mandrel or plug is inserted in the hole. The drill steel is then rolled over the mandrel. After a certain amount of rolling, the mandrel is removed. When the hole has been reduced to about 5/8 in. dia., rolling is continued without further support for the hole.

The process has no advantage other than the good support given to the hole in the early stages. Disadvantages are numerous. In the rolling mill fire, the air and furnace gases have free access to the hole, whose surface becomes oxidized during heating. When the cold mandrel is placed in position and rolling begun, the scale is pressed into the wall of the hole, causing an undesirable rough scaly hole. Moreover, when the mandrel has been removed, the hole is entirely unsupported while rolling is continued down to 1/4 in. or 3/8 in. dia. This results in loss of hole shape and concentricity, while folds may develop lengthwise as the hole is closed down to dimensions.

The Sand Core Process

The sand core process comprises drilling a hole in the billet, plugging one end, and filling the hole with a refractory sand of special type. After the hole is well and carefully packed, another plug is driven in the other end to hold the sand securely in the hole. The billet is then heated and rolled into a bar. Each end of the bar is knocked off, and the sand is removed by inserting a tube in the hole. The tube is coupled up with an air compressor, which drives the air up the tube at a pressure of 800 to 900 lbs. per sq. in., and blows out the sand, leaving the bar with a hole down the center along its entire length.

While this process insures that the atmosphere and furnace gases do not have access to the hole, and hence oxidation on the inner surface is minimized, there may be slight oxidation due to contact with the sand. Apart from this, three serious disadvantages arise from this method.

First, grains of sand become embedded in the wall of the hole, and after the sand has been blown out, small indentations are found in the surface of the hole. This concentrates stresses at these small pits when the steel is put to work, and often fatigue cracks develop and proceed from the hole until the section is weakened to such an extent that premature failure occurs.

Secondly, when drills are in service in the mine, water is passed down the hole to prevent dust, and the small recesses in the hole caused by the sand packing accelerate corrosion. The smoother the surface of the hole, the greater the resistance to the corrosive action of the water.

Lastly, while sand supports the hole during rolling, this support is inadequate, and the hole often becomes distorted. Oval and rectangular holes are often found in consignments of hollow drill steel produced on a sand core.

The Copper Core Process

Britain originated the copper core process, which is still used in that country alone. A hole is drilled down the center of the billet, and a rod of copper inserted. The billet is then heated and rolled, and when it is cold, the copper rod is extracted, leaving a hole throughout the entire length of the bar.

This is undoubtedly an improvement on the sand core process, but has certain drawbacks. Copper is a soft metal, and this softness becomes extremely pronounced at elevated temperatures. With a melting point of 1083 deg. C. (1980 deg. F.), it offers little resistance to deformation during rolling. There is, therefore, a marked tendency for hollow bars thus prepared to have a hole of irregular shape. Moreover, the steel does not acquire the fine struc-

ture so desirable in drill steel bars. If the billet is heated without the copper in the hole, the walls of the hole become scaly and suffer from roughness.

The Metal Core Process

The modern British method of making drills is the metal core process, in which a hole is drilled down the center of the billet and a rod or core of special steel placed in it, this steel having a higher coefficient of expansion than the drill steel itself. The billet is then heated up and rolled. After cooling, the ends of the drill steel bar are cracked on the anvil, then placed in a machine, one end and the middle being secured in jaws. One set of jaws is fixed and the other transversed by mechanical means, thereby exerting a pulling action on the metal core. This elongates the core considerably before it fractures. The cross sectional area is thus reduced, the core becomes loose in the hole, and is easily extracted.

The operation is less simple than it sounds, and depends for its success on four factors: (a) The core must elongate sufficiently before breaking to reduce the cross sectional area sufficiently to leave it loose in the hole and capable of easy extraction; (b) the core composition must be such that the reduction of cross-sectional area is not localized, but extends fairly evenly throughout its entire length; (c) the rigidity must be such that the core will adequately support the hole during rolling; (d) the melting point must be higher than the temperature at which rolling of the drill steel is carried out, and the characteristics (a) and (b) preserved after the material has been heated to the rolling temperature.

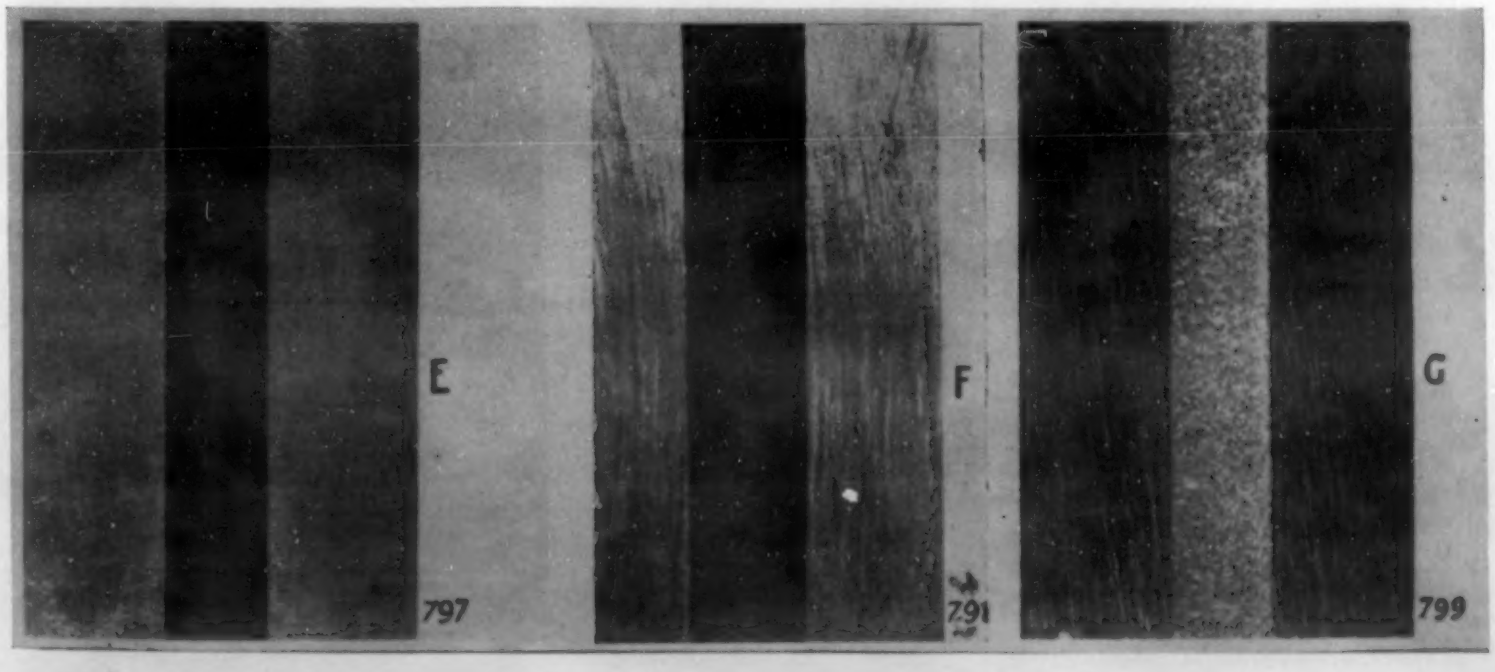
This process provides the ideal conditions of manufacture for hollow bars, having none of the disadvantages and all the advantages of the other methods. The metal used for the core has a high melting point, and is harder than the drill steel at the rolling temperature. When rolled, it imparts to the wall of the hole a very smooth surface, far superior to that produced by other processes. The high resistance offered by the core exerts a most beneficial effect on the drill steel structure, giving a fine grain. It furnishes adequate support during rolling, fully maintaining the shape and concentricity of the hole.

The Special Core Steel

It will be seen clearly from Figs. 6 through 12 that the metal core process gives the best surface. The analysis of the core steel used makes it necessary to confine the rolling between well-defined limits of temperature. At a temperature higher than 1080 deg. C. (1975 deg. F.), the core will not stretch sufficiently to be taken from the hole. This is almost as effective as mechanical control of the rolling temperature, and safeguards the drill steel from being overheated, while insuring a fine structure in the "as rolled" condition.

The table at the bottom of page 324 shows tests obtained from the special core steel, from which it will be seen that the steel has a remarkable elongation when pulled:

Figs. 6, 7 and 8. Sections of bars made by different processes. The hole is exposed to show differences in smoothness of wall and in face. E is a metal core; F, a copper core; and G a sand core.



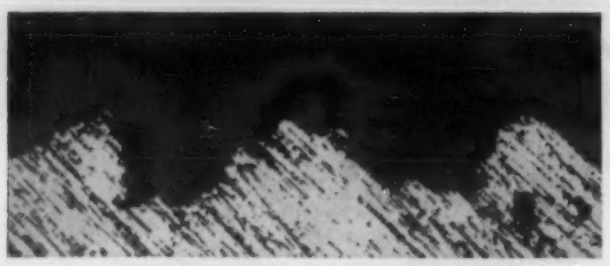


Fig. 9. Mandrel-rolled hole. Wall surface of hole, 90X.

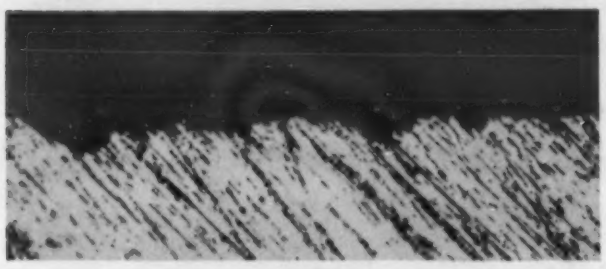


Fig. 10. Sand-rolled hole. Wall surface of hole, 90X.

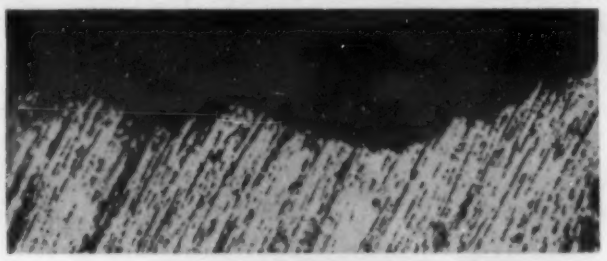


Fig. 11. Copper-rolled hole. Wall surface of hole, 90X.

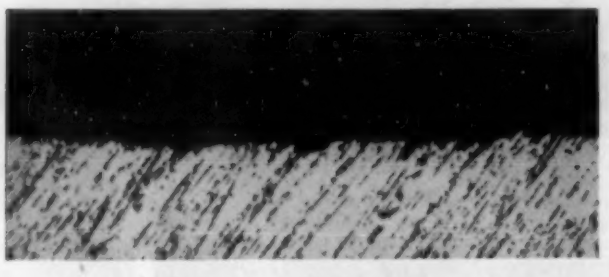


Fig. 12. Metal-rolled hole. Wall surface of hole, 90X.

The various test-pieces stretched 65 to 74 per cent of their original length before fracture took place. Another feature is the higher relative expansion than that of ordinary steel. When cooling down from elevated temperatures, the contraction is greater than that of ordinary steel, so that when the core is cooled from the rolling temperature, it will be looser in the hole, and this, with the abnormal reduction of area mentioned, makes mechanical extraction easy.

Casting Around a Tube

Casting drill steel around a tube is being largely used as a method of producing drill steel for mining purposes in one of the Dominions.

A steel tube is placed in the center of a mold, and molten drill steel poured between tube and mold. When cold, the result is an ingot with a hole down the center, which is rolled into hollow drill steel bars. The hole is formed by the tube, and welded around it is the main body of the drill steel.

The novelty of this method constitutes its chief attraction. The influences at work during solidification, however, make for the location of impurities midway between the hole and the outside of the bar, which is a most vital and undesirable position.

Solidification begins at the face where the liquid steel is in contact with the cold tube, and also from the surface touching the outer cold mold. As the liquid solidifies, non-metallic inclusions are driven in front of the solidifying metal and forced into the position stated, where they are eventually trapped when the last liquid freezes. The portion of steel that eventually forms the body and cutting edges of the drill has therefore to harbor the undesirable elements that impair the efficiency of mining drills.

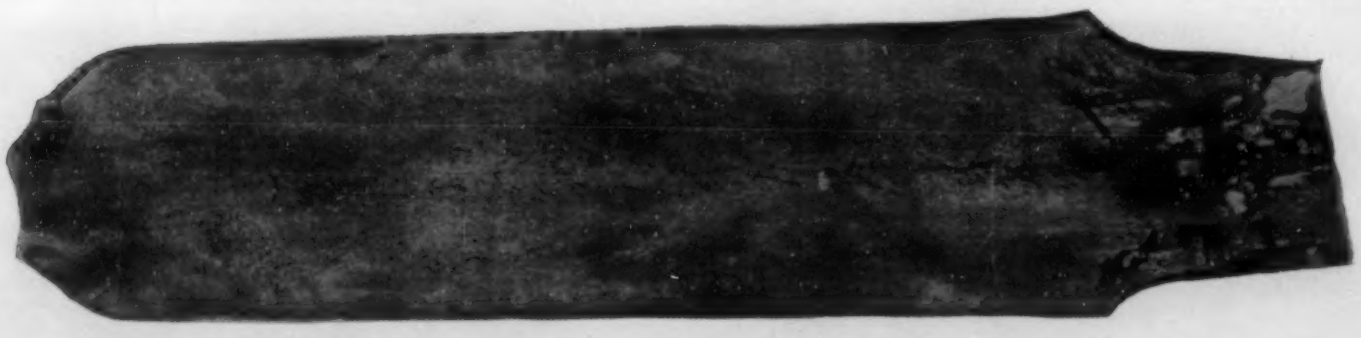


Fig. 13. Sulphur print of drill steel ingot, showing disposition of impurities.

Table of Tests from Special Core Steel

Test Piece	Max. Stress, lbs. per sq. in.	Elong., Per Cent
1	163,250	73.7
2	162,450	65.7
3	168,000	74.1
4	157,000	66.8

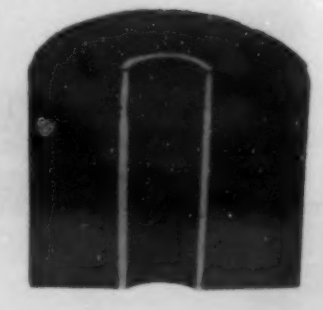


Fig. 14. Section cut down center of stainless-lined hollow drill, etched to show stainless steel lining.

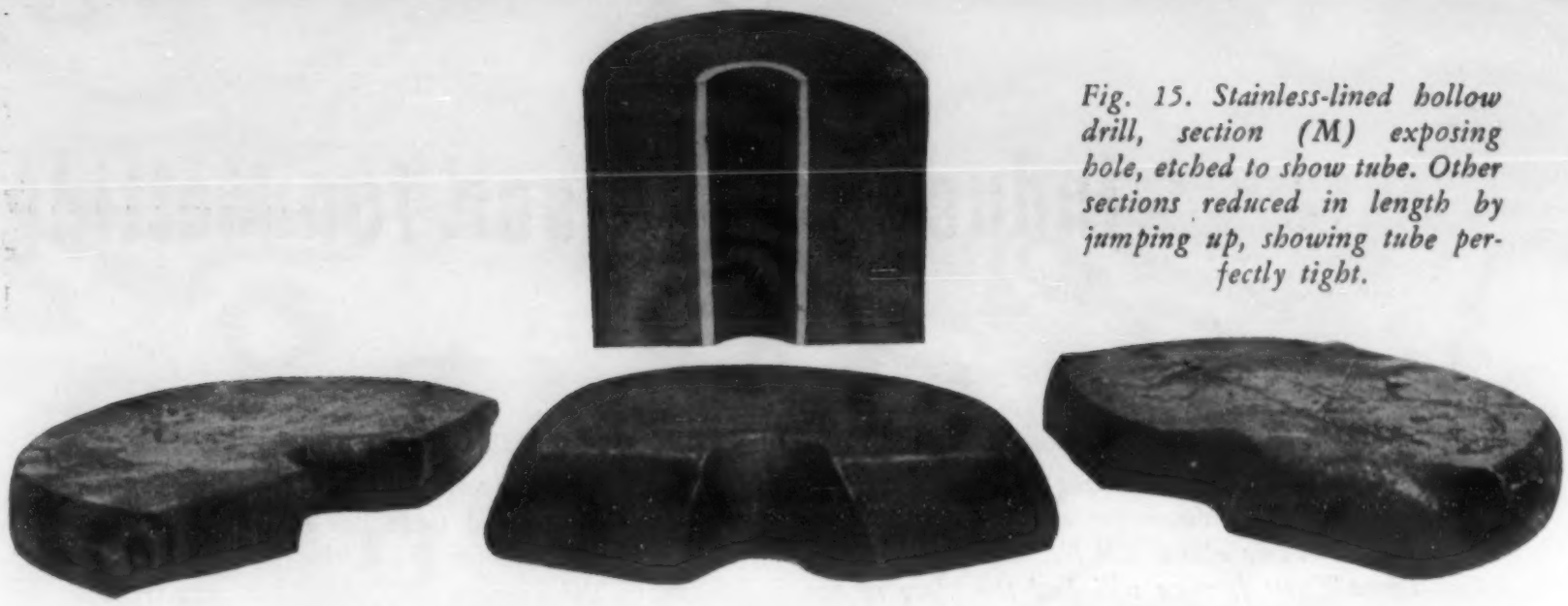


Fig. 15. Stainless-lined hollow drill, section (M) exposing hole, etched to show tube. Other sections reduced in length by jumping up, showing tube perfectly tight.

The ingots made by this method are comparatively small, and as a result, need little mechanical work for their conversion into hollow bars. Thus, the dendritic structure is not thoroughly broken down by cold or hot working, and service results are impaired as a natural consequence.

In ingots cast in the normal manner, the undesirable inclusions run down the center. Fig. 13 shows a sulphur print of a solid ingot. The sulphur content can be clearly seen confined to the area near the center line of the ingot. The drilling of the ingot down the center removes the portion of steel likely to contain harmful impurities and inclusions, thus precluding trouble from this source.

Stainless-Lined Holes

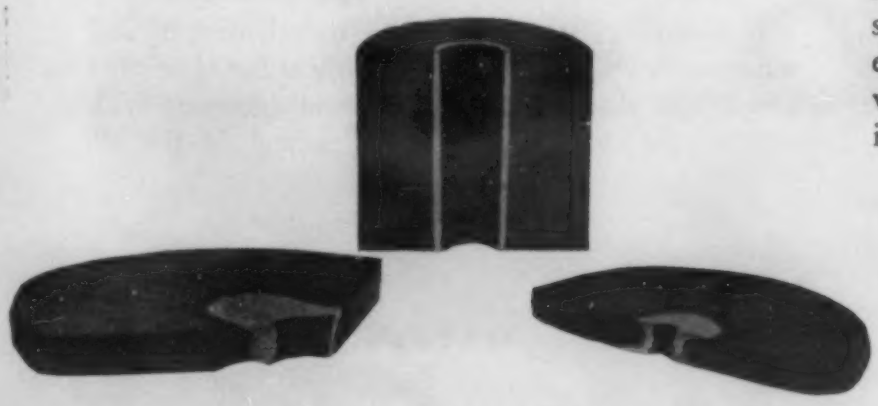
In recent years much research has been done on corrosion of the hole surfaces in hollow drill steel. This is closely related to the composition of the water running through the hole. Where the water contains acids, alkalis, and salts, the hole walls may encrust or corrode sufficiently for drill life to be shortened. Corrosion is accelerated if the hole walls are rough, as in hollow steel prepared on sand. When corrosion occurs, any small seat from which it begins forms the nucleus of a crack, and the material breaks down more readily than if corrosion did not occur.

To overcome corrosion, British manufacturers sometimes line the hole with a tube of stainless material resistant to the corrosive action of impure water. The lining can be secured to the hole without any fear of its working loose in service. This is achieved by a special process. The price of stainless-lined hollow drill steel is, of course, higher than that of ordinary drill steel, and still higher if the special fixing process is required. The illustrations, Figs. 14 through 16, show the results of experiments carried out on fast-lined hollow drill steel in an attempt to dislodge the tube, an attempt entirely unsuccessful.

A piece of hollow steel with a stainless lining was cut in two, exposing the hole (see M, Fig. 15), leaving the tube free to come out if loose. It was then heated in a furnace and reduced in length from 2 in. to about 1/4 in. by hammering (see Fig. 15). The tube remained intact.

Some of the pieces were ground and afterwards etched with nitric acid (spec. gr. 1.20), and Fig. 16 shows distinctly the deformation of the stainless tube without any signs of dislodgment from the steel drill body. A bend test also proved the tube perfectly secure.

Fig. 16. Stainless-lined drill—same as Fig. 15, but jumped up pieces ground to display more clearly the stainless lining, still intact although severely distorted.



For Drilling Hardest Rock

British manufacturers also supply and make an oil hardening alloy mining drill steel, advantageous for drilling the hardest rock. Suitably treated, it retains its cutting edge better than plain carbon drill steel, and will, in consequence, permit a higher cutting speed.

The advantages of this material are greater hardness, increased cutting properties, and the necessary shank hardness without heat treatment. Natural hardness in the rolled condition is a great advantage, as it minimizes the risk of wear of the cutting edge causing premature failure.

If the shank is machined and not forged, as in the bolster chuck shank, the natural hardness of the material also eliminates the necessity for heat treatment of the shank, whereas most other types of drill steel need shank treatment before the drills are hard enough to withstand the blows of the hammer piston without burring and causing the shank to become fast in the hammer.

Induction Furnace for Melting

With all the aluminum that is now being melted for war use (and the correspondingly large amounts that will be processed when peacetime production predominates) the development of an induction melting furnace for aluminum alloy is of outstanding interest. Time alone will tell whether the new Ajax-Tama-Wyatt furnace will find the place in the aluminum field that its elder brother, the Ajax-Wyatt unit, has established in brass and bronze melting. The operation, advantages and limitations of the new furnace are described by its inventor in this article. —*The Editors*

BY MANUEL TAMA

Vice President, Ajax Engineering Corp., Trenton, N. J., division of the Ajax Metal Co.

THE LOW FREQUENCY induction furnaces, largely used in the copper and brass industry, have now been successfully adapted to the melting of aluminum and its alloys.

Difficulties were encountered in the development of the aluminum alloy furnaces, on account of the low density of the metal and of the fact that the slags have no marked tendency to float, as is the case with heavy metals. The aluminum alloy slags tend to contaminate the melting channels of induction furnaces. The slags are non-conductors, and if any amount of them incrustates the melting channels it will increase their resistivity and the power absorbed by the furnace will tend to decrease and finally to stop. These difficulties can be overcome by the proper design of the melting channels.

Construction of the Furnace

Figs. 1 and 2 are vertical cross sections, in planes 90 deg. apart, of a single-phase furnace for aluminum alloys. The primary coil, A, made of mica or glass tape insulated copper strip, is arranged around the transformer core, B, fabricated of high permeability silicon steel sheet. A transite tube, D, surrounds the coil and insulates it from the lining of the furnace. The blower, C, and adequate cooling ducts are provided to keep the transformer winding and core cool during operation.

When alternating current of standard frequency is passed through the primary coil, A, a current is induced in the metal contained in the secondary loop or melting channel, EFEG. The amount of energy so transmitted from the primary coil to the melting channel depends on the voltage and frequency of the current applied to the primary coil, on the number of turns of said coil, on the shape and size of the melting channel and on the resistivity of the metal being melted.

The melting channels open into the hearth, P, containing the molten charge. The heat is generated only in the melting channels and transmitted rapidly to the hearth by virtue of electromagnetic forces which keep the metal in permanent circulation. This wireless or electrodeless transmission of heat creates ideal conditions of temperature gradients within the molten metal.

The highest temperature is found at the bottom of the melting channels, slightly lower temperatures prevail in the hearth or crucible and much lower temperatures are found in the atmosphere above the metal bath. If the molten charge in the hearth is kept, for instance, at 1300 deg. F., the bottom of the channels attain a temperature of 1380 deg. F., while the air on top of the bath shows only 950 deg. F. The low coefficient of emissivity of aluminum alloys is responsible for these ideal conditions.

By the same reasoning, in fuel fired or electric furnaces in which the heat is transmitted by radiation (reverberatory furnaces or electric resistor furnaces) very high temperatures, over 2000 deg. F., must be kept above the melting chamber to insure efficient heating.

The low ambient temperature above the molten charge helps in reducing the melting losses and the gas pick-up. A prominent British company using induction furnaces for aluminum alloys on a large scale reports that over a long period of time the metal losses and the gas absorption rate of induction furnaces were compared with those of fuel-fired reverberatory and crucible furnaces and that the results showed a saving in favor of the induction furnaces, of 50 per cent in metal losses and of 66 per cent in the amount of fluxes used for degassing.

Absence of Harmful Gases

It has long been established that hydrogen and water vapor are the most harmful gases for aluminum alloys and that the absorption rate increases with temperature. Hydrogen is not present in the at-

Aluminum Alloys

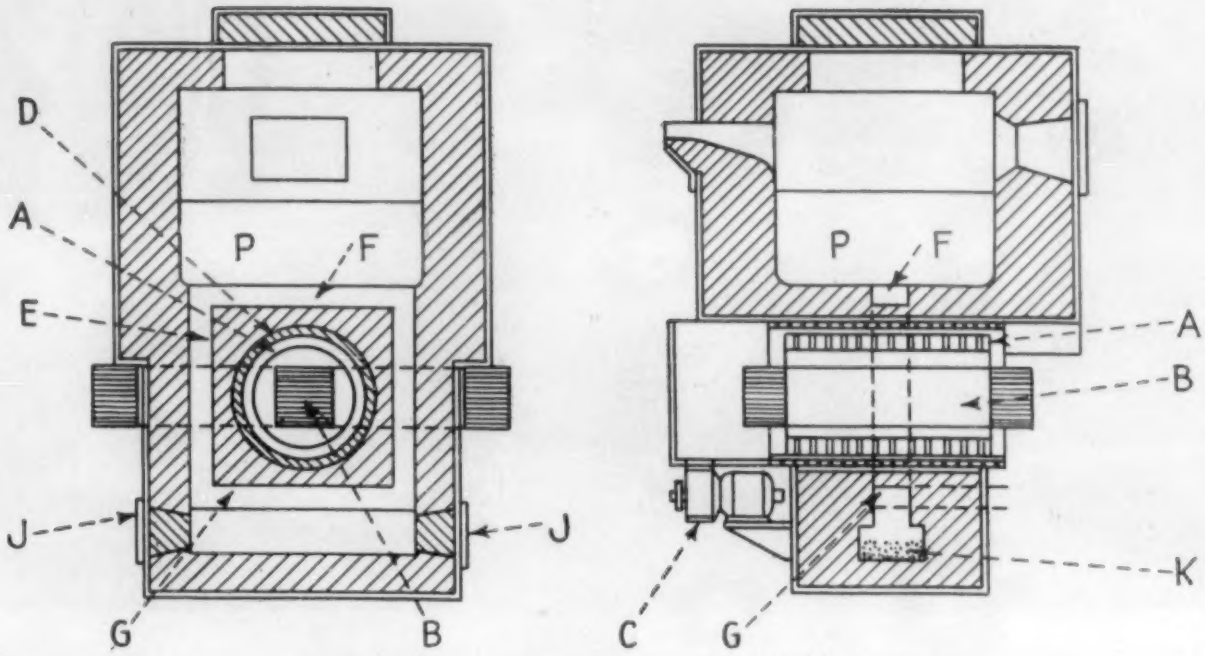


Fig. 1. (Left) Vertical cross section of the furnace.
Fig. 2. (Right) Cross section of furnace 90 deg. from Fig. 1.

mosphere of an induction furnace. Steam may be present in humid weather, but the low temperatures prevailing above the melting chamber are not sufficient to dissociate the steam to form hydrogen. Gases may be brought into the bath with the scrap charged into the furnace but they seem to be expelled to the surface by the permanent stirring of the melt. At any event, repeated experiments have demonstrated beyond doubt that melts prepared in induction furnaces show a high degree of soundness.

The automatic stirring of the metal bath is a characteristic feature of all induction furnaces. In melting aluminum, the head of molten metal contained in the hearth must be high enough, so that the protective skin of aluminum oxide formed on the surface should not be broken. If this precaution is observed, the automatic stirring has only beneficial effects for the proper melting of aluminum alloys insofar as uniformity of temperature and of chemical composition are easily obtained within the charge.

Another advantage of the electromagnetic stirring is that, in many cases, ingredients of high melting point like copper or nickel can be dissolved directly, thus eliminating the use of hardeners. Copper can be readily dissolved in the amount indicated by the constitution diagram at a given temperature. This can be easily demonstrated by holding a copper bar in the aluminum bath. Due to the rapid movement

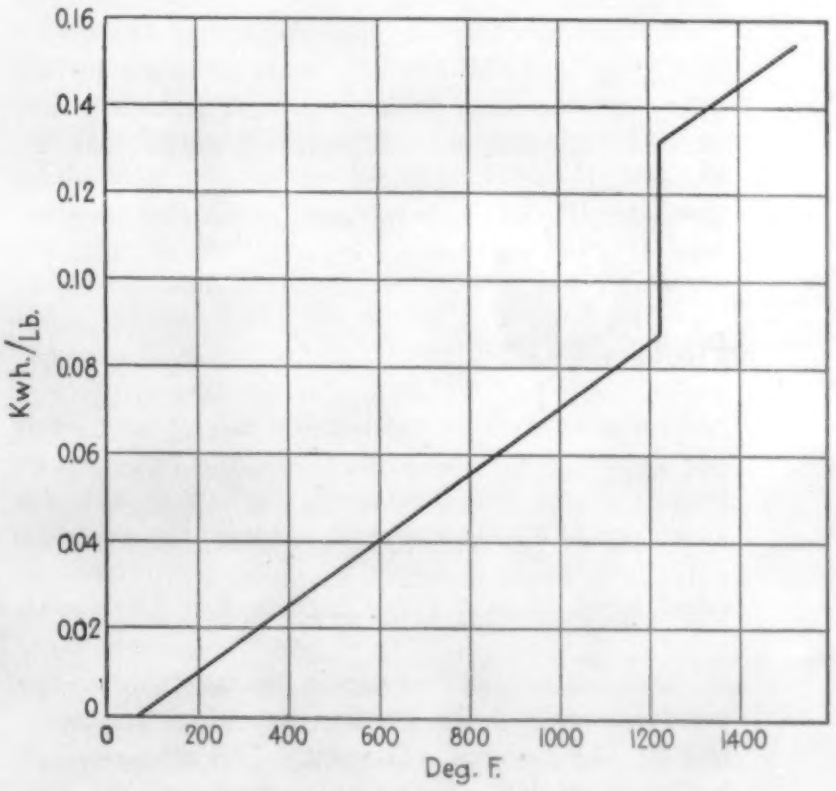


Fig. 3. The theoretical amount of energy in terms of kilowatt hours to heat 1 lb. of aluminum from room temperature to any desired temperature, in terms of deg. F.

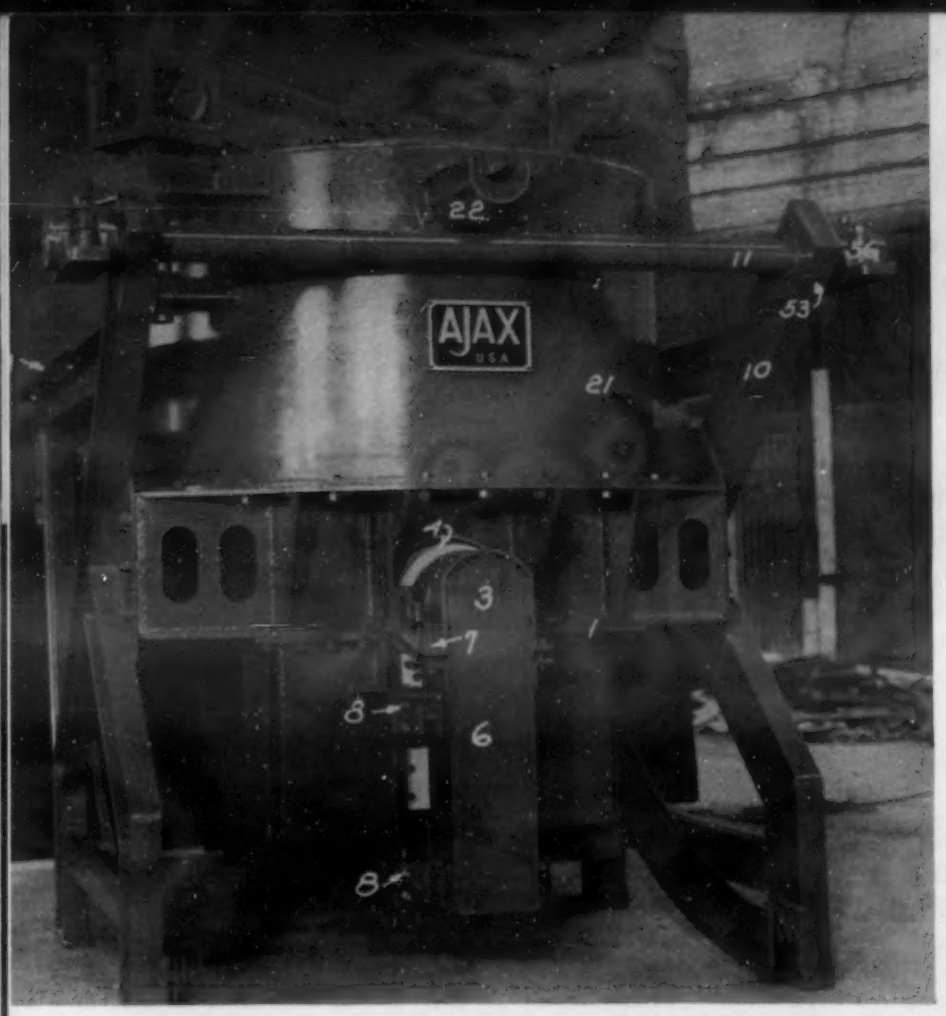


Fig. 4. A 250-kw. induction furnace for aluminum alloys with a capacity of 1 ton of molten metal. This is the front view.

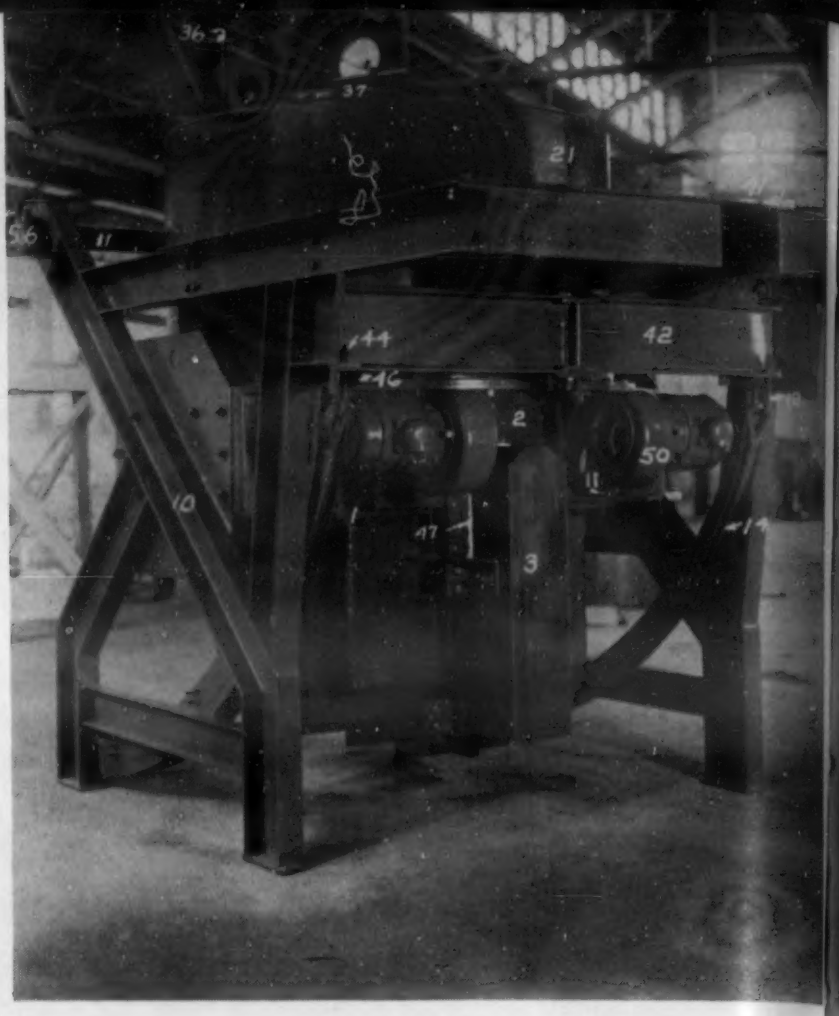


Fig. 5. Rear view of same furnace as Fig. 4.

of the aluminum, copper is dissolved before its melting temperature is reached.

Fig. 3 shows the heat content of pure aluminum versus temperature; *i.e.,* the theoretical amount of energy in terms of kilowatt hours necessary to heat 1 lb. of aluminum from room temperature to any desired temperature. It will be noted that the theoretical energy required to bring aluminum to 1350 deg. F., which is the average pouring temperature, is 0.141 kw. hr. per lb.

Production Rate

In electric melting practice the production rate is usually expressed in terms of pounds per kilowatt hour. Thus, the theoretical production rate for aluminum to a temperature of 1350 deg. F. would be equal to $\frac{1}{0.141} = 7.1$ lbs. per kw. hr. The practical rate obtained in furnaces in operation up to the present is about 5 lbs. per kw. hr., which is equivalent to 70.5 per cent efficiency. This efficiency can be improved by reducing the capacity of the furnace; *i.e.,* the weight of the charge to be tapped from the furnace and at the same time increasing the power absorbed by the furnace. In the application of induction furnaces, therefore, careful consideration must be given to the necessary weight of the charge. Furnaces of small tonnage provided with high power ratings should be given preference, whenever possible.

Induction furnaces can easily be provided with permanently immersed thermocouples connected to automatic temperature recording and controlling instruments. Because the temperature of the bath is uniform, only one thermocouple is necessary. The temperature of the bath can thus be kept to close limits. Inasmuch as the energy is applied directly to the metal, there is no time lag between application of power and increase of temperature.

Manipulating the Slag

Returning now to Figs. 1 and 2, it may be explained that the melting channel has two vertical straight legs, E, which enter abruptly, without flaring openings, into the hearth, P. This feature is important, because the straight legs of the channel can easily be cleaned with straight bars during the melting operation, without emptying the furnace. The abrupt change of cross sections develops a sort of "barrage" to prevent slag particles from entering into the channels.

The electromagnetic force usually known as "pinch effect" is responsible for expelling small particles out of the channels into the hearth. The slag is thereby brought to the surface, where it can be skimmed out from time to time. The lower horizontal portion, G, of the melting channel can be cleansed from time through the two openings at bottom, which are kept sealed by adequate plugs, J.

Figs. 4 and 5 show photographs of a 250-kw. induction furnace for aluminum alloys having a charge of 1 ton of molten metal. Fig. 4 shows the front

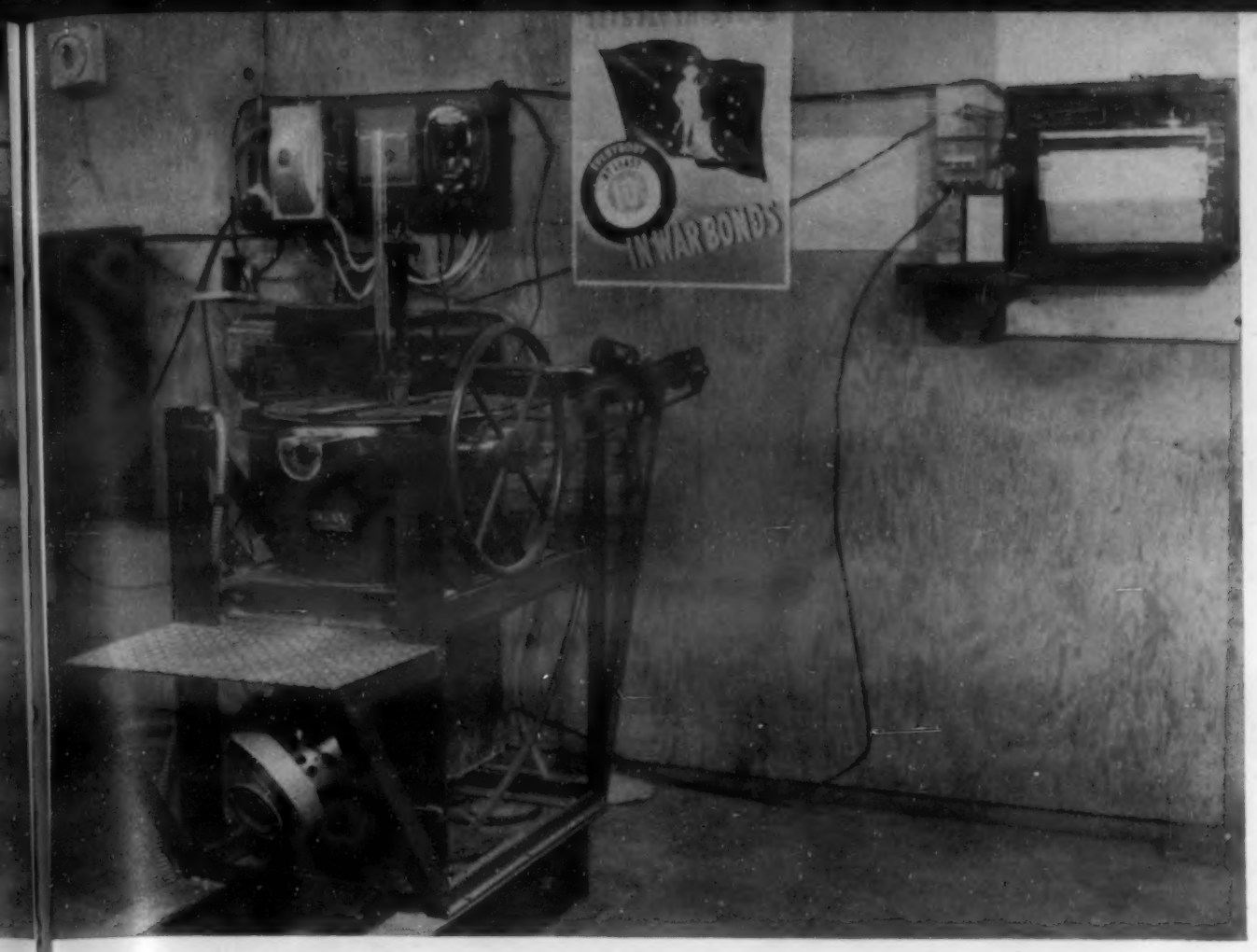


Fig. 6. An induction laboratory furnace of 10 kw. capacity, capable of producing about 50 lbs. of aluminum alloy per hour.

and Fig. 5 the rear side of the furnace. It will be noted that the furnace body has been made entirely of welded steel structure and that a part of the foundry platform is attached to the furnace, thus forming a level floor for easily charging the furnace.

Fig. 6 shows a laboratory furnace of 10 kw. capacity, capable of producing about 50 lbs. of aluminum alloy per hour. This furnace is very handy for experimenting with new alloys, determining adequate pouring temperatures, melting losses, methods of degassing, slag reactions and carrying out any other metallurgical manipulations required in the research laboratory. In this particular case the furnace is provided with a recorder and controller which holds the temperatures within 5 deg. F.

The linings of these induction furnaces are rammed from mixtures of cheap refractories. No critical materials like graphite are used.

Obviously, the heat dissipated from the furnace walls is low, the temperature of the walls being around 180 to 200 deg. F., and no fumes or gases are expelled from the furnace, thus increasing the comfort for the melting crew.

In the Casting Shop

During the development stage of the induction furnace for aluminum alloys, by far the largest interest was found among the rolling and extrusion mills, and it followed that furnaces of large capacity were required. The aluminum industry has been following the lines of the steel industry. Billets and slabs of considerable size are used for extrusion and blooming. In fact, the requests of the wrought aluminum alloy industry in respect to size of castings surpass anything that has been previously demanded by the copper and brass industry.

Furnaces of 125, 250, and even 500 kw. have been developed and are under manufacture for these mills; and in the United States, where a considerable number of mechanized foundries for large production of sand castings, permanent mold castings, and die castings, are already operating, and where more foundries of this type are being erected, it has been found by contact with the foundry industry that the induction furnace may also find a remarkable acceptance in it.

The trend of the aluminum producers and of the secondary melters in this country is to deliver pigs of specified analysis ready to use in the foundry. The actual predominant practice in this country is to melt the aluminum pigs in the reverberatory furnace, and to ladle out metal in the molten state, so as to bring a smaller charge to the holding furnace.

By the use of induction furnaces, the holding furnace can be eliminated. The solid aluminum alloy pigs can be charged continuously to the small induction units, and the molten metal can be discharged also continuously from these furnaces to feed the molds.

Adequate temperature controllers help to keep the molten bath at the desired casting temperature within close limits, and automatic devices have been designed to charge the pigs continuously to the induction furnace which acts as a melting and holding unit at the same time. Obviously, this results in economy of operating costs and space.

Chromium-Manganese "Stainless" Irons

PART ONE

Although both nickel and manganese are "strategic" metals, nickel is right now much more critical than manganese. Considerable interest is being shown, therefore, in stainless irons and steels in which part or all of the nickel is replaced by manganese. It should thus be helpful to have this report of the engineering properties and corrosion resistance of austenitic chromium-manganese irons as related to their composition, structure and treatment.

This article is based on the author's Master's degree thesis at Rensselaer. The thesis also won a prize in the Electro Manganese Corporation's contest.

—The Editors

BY JOHN M. PARKS

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IN VIEW OF THE EVERSHIFTING FACTORS that control the production of metals during periods of war, an adequate knowledge of the properties of all alloy systems is essential. In view of possible shortages of essential alloy additions, an investigation of the austenitic iron-chromium-manganese alloys was undertaken, using essentially carbon-free alloy additions.

Review of the Literature

Due to the recent development of electrolytic manganese, which has made a supply of carbon-free manganese commercially available, little appears in the literature concerning the chromium-manganese irons. However, considerable work has been accomplished with respect to the chromium-manganese steels. Guillett[1] in 1906 first investigated these steels, later Becket[2] dealt with their heat and corrosion resistance. In 1933, Köster[3] investigated the structure of these steels and found the high manganese steels austenitic when they contained a chromium content up to 13 per cent. In 1934 Gunzberg, Aleksandrova, and Gelderman[4] investigated the rust resistance of these alloys. In the following year Schafmeister[5] as well as Chimusin and Kurowa[6] discussed the application of low chromium, chromium-manganese steels for use in aircraft construction.

In 1936 Brühl[7] made an intensive survey of these steels with respect to constitutional changes due to heat treatment and variation of carbon content. The weldability, impact strength, heat resistance, and corrosion resistance were studied with respect to structural changes. X-ray diffraction, dilatometric surveys, and temperature-temperature differences curves were used in this investigation to determine the exact nature of the transformations. Schmidt and Legat[8] in 1936 also studied the heat resistance of the chromium-manganese steels. Burgess and Forgeng[9] in 1938 investigated the structure of these alloys and discussed the possibility of sigma phase formation rather than the iron-chromium compound formation. A similar study was also made by Wever and Jellinghaus[10, 11] who considered the formation of the compound Fe-Cr and investigated it by X-ray diffraction methods. In 1938, Schafmeister and Ergang[12] studied the formation of the sigma phase in the iron-chromium-manganese system and indicated that this phase could form in the region beginning at 15 per cent Cr for the alloys from 12 to 50 per cent Mn.

Legat[13] in 1940 investigated the physical properties and the corrosion resistance of the 18 Cr, 9 per cent Mn steels. Guzzoni[14] investigated the mechanical properties and corrosion resistance of the austenitic-ferrite steels in this system.

The iron-chromium-carbon system was found to be similar to the iron-chromium-manganese-carbon system by Tofaute, Küttner, and Büttinghaus[15]. Wolfson and Brozdyka[16] made short time creep tests on these steels. Gillett's comment[17] on the results of their investigation is of great interest. Monypenny[18] gives a short but excellent summary of the work which had been accomplished up to 1937.

Melting the Alloys Tested

The metals used in making the chromium-manganese alloys consisted of Armco iron punchings, electrolytic manganese, and low carbon chromium. The approximate analysis of these components is given in Table I.

Table I—Approximate Analysis of the Alloy Components

Armco Iron	Electrolytic Manganese	Chromium
0.015% C	99.95% Mn	99.2% Cr
0.025% Mn	0.02% Fe	0.005 C
0.003% Si	0.03% S	
0.005% P		
0.025% S		
bal. Fe		

Polishing a sheet of stainless steel (Courtesy: Republic Steel Corp.)

All alloys were melted in a 5-lb., basic, high frequency induction furnace using a 10 kw. power input. The iron and chromium were charged and melted under a glass slag. After the metal had completely melted down, the glass slag was partially removed and the manganese added. The manganese tends to deoxidize the bath and the resulting oxide makes the slag very fluid. After the manganese has dissolved in the bath, silica sand was sprinkled on the bath to absorb the fluid slag. This sand was immediately removed and the metal cast into 2000-gram ingot molds. The total time of melting ranged from 30 to 50 mins. Ingots were machined to remove surface defects and then forged in the temperature range of 1800 to 2000 deg. F. After forging, the alloys were hot rolled into ¼-in. rod.

Melts of these alloys were first made in a clay-graphite crucible lined with alundum cement, but the fluid slag readily attacked the sodium silicate binder in the alundum cement and carbon from the crucible dissolved in the bath. As the carbon content in the alloys is desired as low as possible, this type of crucible is deemed worthless for melting. A magnesia crucible was tried and found completely satisfactory for melting these alloys.

Composition and Structure of the Alloys

Irons containing 12, 20 and 30 per cent Mn with 12 per cent Cr and irons containing 12 and 20 Mn with 5 per cent Cr were made. These irons all lie in the austenitic region at 1290 deg. F. according to Schafmeister and Ergang[12] and no sigma phase should exist in these irons provided the influence of carbon can be neglected.

The metallographic investigation was made in order to determine the alloy structure so that it could be correlated with the physical properties. The "hot rolled" rod was examined as well as specimens which had been furnace cooled and water quenched after a 2-hr. heat treatment at 1800 deg. F.

In general, the iron which was to be investigated was mounted in bakelite, dry polished through the metallographic papers, wet polished first by use of

Cold rolling stainless steel into coils at one of the large plants of the Republic Steel Corp.

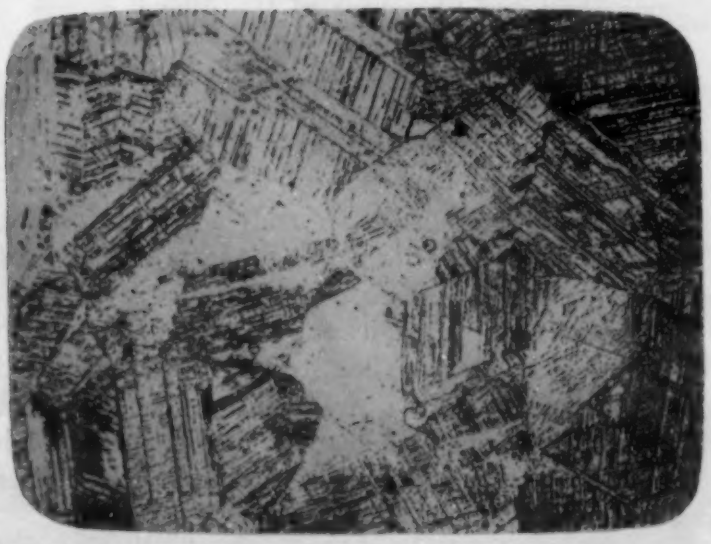

Fig. 1. A 5 Cr, 20 per cent Mn iron, water quenched from 1800 deg. F. 100X.

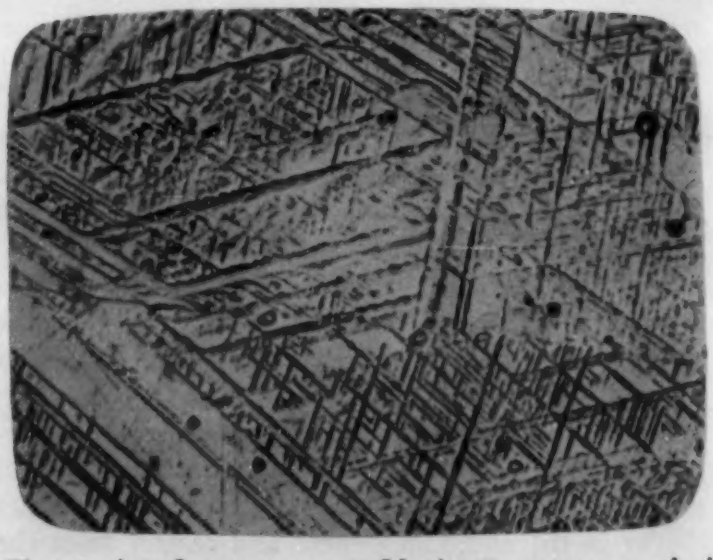

Fig. 2. A 5 Cr, 20 per cent Mn iron, water quenched from 1800 deg. F. 1,000X.

alundum paste and then by use of relevigated alumina, etched with a solution of hydrogen peroxide and nitric acid dissolved in glycerine, and examined at 100 and 1000 magnifications. The etching solution consisted of 10 parts nitric acid and 10 parts hydrogen peroxide dissolved in 20 parts of glycerine. Hydrochloric acid was added to this etchant in order to increase its activity. Usually a drop or two of concentrated acid to 50 ml. of solution was necessary. The etching time varied from 30 sec. to 2 mins.

The microstructure of the "hot rolled" rod showed a very fine-grained cold-worked structure. This structure accounts for the variation of this rod and annealed iron.

The water quenched steels show a duplex structure of austenite and rejected ferrite for all of the compositions which were investigated. Fig. 1 which was taken at 100 magnifications shows the microstructure of the 5 Cr, 20 per cent Mn iron which was water quenched from 1800 deg. F. The rejected Widmanstätten structure is ample evidence of the duplex structure of these irons. The twinned grains and the orientation of the rejected phase in these grains offers interesting evidence of precipitation on preferred planes. Fig. 2 shows this same structure at 1000 magnifications. This structure is typical of all of the water quenched irons investigated; the amount of rejected ferrite being the only variable. The rejection of ferrite in this water quenched alloy is unusual in that all similar alloys reported in the literature show no ferritic rejection in this composition range. This effect is undoubtedly due to the absence of carbon in these alloys. Köster indicates that 0.10 per cent C in this alloy will prevent rejection even when cooling under equilibrium conditions. Considering this effect, important physical property changes can be expected by the presence or absence of small percentages of carbon.

Fig. 3 shows the microstructure of the water quenched 12 Cr, 20 per cent Mn iron under a magnification of 1000X. The absence of precipitation on the grain boundaries indicates that the rejection and diffusion process is an extremely slow one and predicts the freedom of these irons from intergranular corrosion. The absence of ferrite in the twinned section is due to an etching-orientation effect. In certain grains, the etching attack is more pronounced than in others and the rejection will not be revealed unless the etching time or activity of the etching solution is increased. Fig. 4 shows the same iron in a different section. This photomicrograph shows a periodic spacing of the rejected phase in both of the Widmanstätten directions. This formation is quite interesting as it may shed some light upon imperfections occurring in crystal lattices as well as indicate the slow diffusion process that occurs in these alloys.

Fig. 5 shows the 12 Cr, 12 per cent Mn iron which was water quenched after annealing 2 hrs. at 1800 deg. F. Comparison of this structure with the other structures indicates that in the range of 5 to 12 per cent Cr and 12 to 30 per cent Mn, increasing chromium content has little influence on the amount of reject while increasing manganese content definitely suppresses the decomposition of the austenite.

Brühl reports that the chromium tends to be higher in the ferritic phase of the duplex ferritic-austenitic-chromium-manganese steels while the austenitic phase tends to be higher in manganese. This also appears to be verified in these irons as the ferritic reject seems to etch less readily than the austenitic phase, apparently indicating a higher chromium content in the

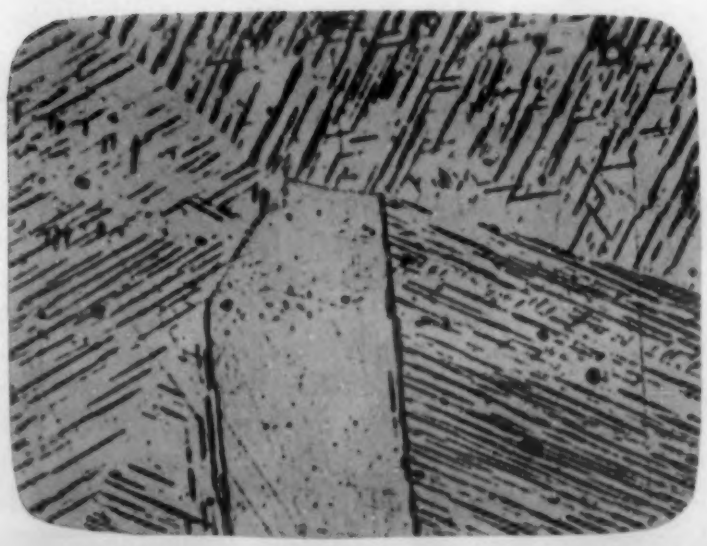

Fig. 3. A 12 Cr, 20 per cent Mn iron, water quenched from 1800 deg. F. 1,000X.

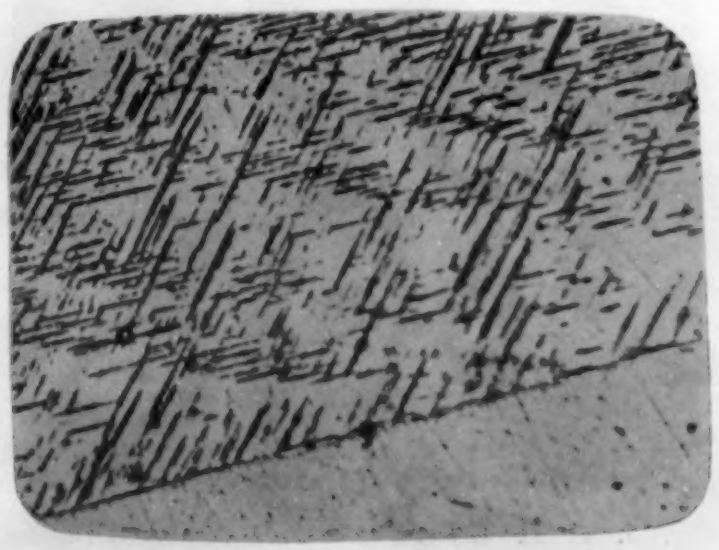

Fig. 4. A 12 Cr, 20 per cent Mn iron, water quenched from 1800 deg. F. 1,000X.

ferrite. The higher chromium content in the rejected ferrite would thus make these alloys readily susceptible to compound or sigma phase formation since it might be possible for the chromium content of this ferritic phase to build up to the required chromium content for sigma phase formation.

When using the glycerine etch, the furnace-cooled alloys show the same general structure as did the water quenched alloys. However, in the 12 Cr, 30 per cent Mn alloy, it is doubtful if any visible reject exists as this structure appears to be a single phase even until the etching pits produced by continued etching make the microstructure difficult to interpret. On etching this iron with Murakami's reagent[9], the characteristic blue colored sigma phase stain appeared; thus indicating that decomposition of the ferrite had occurred in the 24-hr. furnace cool from 1800 deg. F. Decomposition of the ferrite into sigma phase in the other alloys is possible but the microstructures and the relative magnetism of these alloys indicates that decomposition will not occur to such a great extent. Manganese has an influence on this formation but whether it enters directly into the sigma phase or whether it merely influences the distribution ratio of the chromium in the ferrite and austenite is not clear, but it is believed the latter is the case.

Magnetic Properties

The presence of the ferritic phase may be detected by use of a magnet since the ferritic phase is the only phase which is ferromagnetic in this system. It was found that the magnetic attraction of the water quenched alloys always was less as the manganese content increased. This verifies the results of the metallographic investigation, since it was shown in this work that manganese increased the stability of water quenched austenite. Brühl[7] used a quantitative method for determining the presence of the ferritic phase by determining the magnetic saturation values of the steels in question. He found the magnetic saturation value of the chromium-manganese austenite was approximately 500 gauss and that the magnetic saturation value rose sharply as the amount of ferrite increased. His correlation of the magnetic saturation values with metallographic and hardness surveys was excellent.

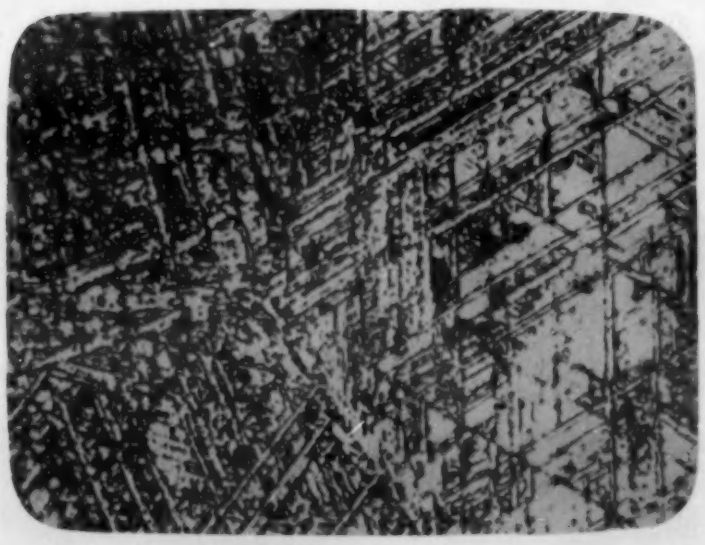

Fig. 5. A 12 Cr, 12 per cent Mn iron, water quenched from 1800 deg. F. 1,000X.

The variation of the magnetic properties with temperature was investigated by the method outlined by Starling[10]. The equipment which was used was not sensitive enough to properly detect the Curie point but from the data that were obtained, it was found that the Curie point for the 12 Cr, 12 per cent Mn steel was near 1100 deg. F. This temperature agrees with the temperature at which austenite starts to decompose into ferrite according to Köster's diagrams[3].

Cold work tends to increase the ferromagnetism of the alloys, a phenomenon which indicates that the austenitic phase is not completely stable and decomposes in the same way as some of the 18 and 8 stainless steels.

Heat Treatment and Hardness

Brühl states that the effect of manganese is to lower the critical cooling velocity and to stabilize the austenitic phase once it is formed. In order to study the influence of cooling rate, specimens were cut from each hot rolled rod and were given two different heat treatments. In one case the specimens were heated to 1800 deg. F. for 2 hrs. in a hydrogen atmosphere and then water quenched. In the other case the specimens were furnace cooled in a hydrogen atmosphere after a 2-hr. soaking at 1800 deg. F. The time required for the furnace to reach room temperature was approximately 24 hrs. Vickers hardness measurements (30 kg. load) were then made on these alloys.

Table II shows the result of this survey. The difference in hardness between the water quenched and furnace cooled specimens is well within the limits of error. This difference in hardness is greatest for heats Nos. 7 and 17. In these cases the difference in hardness may not be an error but may be due to the fact that these alloys have the lowest alloy content and thus possess the least sluggish reactions. A less sluggish reaction would mean that more ferrite would reject in this alloy than in the other alloys when furnace cooled rather than when water quenched and thus the hardness would increase to a greater extent in the lower manganese and chromium alloys.

It will be observed that the hardness of the alloys decreases as the manganese content increases. This substantiates the results of the metallographic

Table II—Effect of Different Cooling Rates upon the Hardness

Heat No.	VPN-30Kg. "Hot Rolled"	VPN-30Kg. Water-Quenched from 1800 deg. F.	VPN-30Kg. Furnace-Cooled from 1800 deg. F.	VPN-30 Kg. Difference Between WQ and FC Specimens
4	293	274	276	2
14*	313	258	262	4
5	345	216	231	15
15*	371	196	196	0
6	311	131	124	—7
16*	321	173	177	4
7	286	278	307	29
17*	289	288	321	33
8	298	208	209	1
18*	307	183	185	2

* Heats 14, 15, 16, 17, and 18 have essentially the same composition as 4, 5, 6, 7, and 8 respectively.

investigation which show that the manganese content causes a decrease in the amount of rejected phase. Since the amount of ferritic phase is small in these steels, the decomposition of the ferritic phase into the compound FeCr would thus have little influence upon the hardness of the resulting steels. This is revealed by studying the hardness of steels Nos. 6 and 16 after they have been water quenched and furnace cooled from 1800 deg. F. Although the reject in the furnace cooled alloy is sigma phase, the influence of each type of rejection is the same. This indicates therefore that the keying effect of small amounts of these two phases in the austenitic grain is essentially the same.

(To be concluded)

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Tin Conservation in Britain—I

BY JOHN IRELAND

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There is great similarity among the steps taken for tin conservation in England and those in the United States. The United States must, however, work out more nearly a 75 per cent reduction in use than one of 50 per cent and we have no domestic mines analogous to the Cornwall deposits.

Our problem is accentuated because we have to export food to our allies, hence dehydration where applicable to such shipments, and use of frozen food and of food canned in glass, particularly for domestic use, must be resorted to. In both places, once electrolytic tinning facilities are operating, the tin pot will rapidly decline in use, save for fixing up "menders" from the electrolytic process.

This instalment features the general aspects of the problem and the specific steps taken to conserve tin in tinplate. The concluding section will deal with conserving the tin used in babbitts, solders and bronzes. —*The Editors*

UNTIL THE OPENING of the war in the Pacific, tin was in abundant supply and its use had been extended to facilitate the more complete allocation of certain other metals to war purposes. For instance, to free aluminum for aircraft, tin-steel hardware was produced, and a tin-zinc foil replaced aluminum for milk bottle caps.

As a result the consumption of tin in Great Britain rose much above its average pre-war level of 22,000 tons per annum. With the loss of Malaya and of the Netherlands East Indies the total supply available to the United Nations shrank to some 80,000 tons per annum, and immediate steps were taken to adjust consumption. A flat cut was deemed impracticable, but a target of 50 per cent reduction was set and every possible measure of conservation has been pursued.

Five Conservation Measures

These have aimed at first, elimination of all uses of tin which under present conditions may be considered superfluous; second, the most economical use of tin where it is indispensable; third, the use of substitutes; fourth, recovery of used metal, as by detinning, and so on; and fifth, stimulation of home-production.

Since the industrial uses of tin are varied, and different problems arise in each, it has been necessary to take the study of each industry as a separate problem. In the first section of this article, it is proposed to deal with certain general questions and with the use of tin in tinplate and hot-tinning, and to deal with other industrial applications in a sequel.

The first statutory action, in July 1940, was taken primarily to conserve steel, but it also reduced the consumption of tin. The use of tin plate was prohibited for such articles as advertising novelties and ornamental trim and for less essential containers. In succeeding months the restrictions were extended and considerable economy was effected by reducing the number of different sizes of containers in which any one product could be packed, and by eliminating the smaller containers, so that the ratio of tin used per pound of product was materially reduced.

On Dec. 8, 1941, the Control of Tin was established, all stocks had to be disclosed and the purchase of tin was permitted only under license. The policy behind the issuing of licenses depended on a close study of the various industries.

De-tinning of Scrap

The return to circulation of already used metal took a variety of forms. De-tinning of scrap had been carried on at a number of works and practically all clean scrap from fabricators works was already taken care of. Used cans presented a more difficult problem, chiefly because they are accumulated in relatively small quantities at the depots of the urban cleansing departments. They arrive there mixed with a wide variety of other metallic scrap and a large proportion of paper, ashes and other refuse.

It has been current practice to carry out only a rough sorting operation of the ferrous scrap and to dispose of it to the nearest blast furnace. Prior to the tin shortage only one de-tinning plant, situated in the London area, was designed to operate exclusively on used tin plate, and it was seldom working to capacity.

The technical operation of de-tinning presents no great difficulties. The chief method in commercial use in Britain is the well-known electrolytic stripping process, using warm dilute caustic soda (2 to 5% at 104 to 140 deg. F.). After from 3 to 5 hrs. the tin is removed, leaving a residue of less than 0.1 per cent. Such steel scrap is freely accepted at the steel furnaces.

One plant situated in the South Wales area detins by direct solution. The scrap is put into an au-

toclave and immersed in a solution of caustic soda, with sodium nitrate as an oxidizing agent, at 15 lbs. gage pressure. Stripping requires about 30 min. The advantage claimed for this process is that used cans can be de-tinned without any preliminary degreasing operation.

Economics of De-Tinning

The economics of de-tinning is governed on the one hand by the value of the tin recovered plus the value of the de-tinned scrap as compared with the tinned scrap, and on the other hand by the cost of the extra sorting, of the de-tinning process, and of the extra transport involved.

The value of the tin is about $8.00 per ton of scrap handled and the difference between de-tinned and tinned scrap is about $4.40. The cost of sorting and transport vary considerably.

The whole question of de-tinning is at present being investigated by the British Ministry of Supply. The existing plants are being kept in operation and the Ministry has taken over the works in South Wales which operates the alkaline solution process. It is possible that moderate sized de-tinning units may be set up in various centers of population so as to get a greater recovery of tin while keeping transport and handling costs to a minimum.

Increasing Cornish Tin Output

The possibility of an increased output of new tin from Cornwall has been carefully studied. Under normal economic forces this industry has been declining in recent years, and the output in 1941 has been estimated at 1,200 tons. The mines at present operating will find difficulty in making any immediate increase in output, as they have given up a large portion of their labor to the army, and during the war years they had allowed development work to fall behind.

A number of old mines could be re-opened, but this would involve a good deal of new machinery, and the withdrawal of the necessary labor from the forces or from war industries. The re-working of old dumps or the dredging of certain alluvial areas are possibilities, but on balance, are not expected to make any considerable contribution under present circumstances.

An examination of Britain's dormant metal stocks has proved more fruitful. Germany is stated to have found many thousands of tons of tin, in the form of piping through which beer was pumped from cellar to counter. Tin was not in use for this purpose in England, but quite a large amount of tin alloy is estimated to be available from the stocks of type carried by printers.

Cutting Down Consumption

The only remaining measure of conservation was the cutting down of tin used in essential industries. Problems of substitution at once arose, but as no two elements duplicate each other's properties exactly, no single metal can be put forward as a substitute for tin. If, however, each use of tin is considered separately, it is found that the more important qualities which tin has provided can be duplicated with greater or less success by some other substance, and a measure of substitution can be effected.

Tin plate normally absorbs about 40 per cent of all tin used. In this industry, tin provides the under-

Specimens of black plate and electrolytic tinplate exposed outdoors in an urban atmosphere for 48 hrs. (rainfall, 0.4 in.) These show the considerable degree of protection given by very thin coatings of tin.

lying steel with a surface which resists corrosion, is non-toxic, and is readily solderable. Quite a number of other protective coatings are available, and copper, lead, zinc, nickel, and cadmium are already in use. None of these are, however, accepted as satisfactory in contact with foodstuffs.

There are also a number of non-metallic coatings based on synthetic resins. These have admirable qualities in contact with food and have an established place in industry, chiefly for the internal linings of vats, tanks, and so on, but they are relatively costly and deficient in mechanical properties.

The extent to which all these metallic and non-metallic coats can be substituted is also limited by their own restricted supply position, and as the plastics are the end product of a considerable chain of chemical operations, no large expansion in production is possible in war-time. Protection can also be given to steel by paints and lacquers, either alone, or combined with a preliminary chemical surface treatment depending, usually, on some phosphoric compound. This substitution is limited by the cost of the plant required, the degree of protection obtained, the mechanical weakness of the surface and the fact that such surfaces cannot be soldered.

Use of Lacquered Blackplate

Lacquered blackplate, with or without a "bonderizing" treatment, has been adopted for can bodies for certain dry packs, for can ends on bodies made of tin plate, and for ends and closures of a variety of containers made of glass, paper and so on. Soldering is however, difficult, and on the can-making lines it has so far proved an obstacle to any wide adoption for can bodies.

Some substitution has been effected by the use of lead-tin alloys of the terne plate type. Terne plate enjoyed a considerable market for such tasks as roofing sheets, and for this purpose an alloy containing 12 to 15 per cent Sn was used. In adapting terne to tin plate jobs where the toxic qualities of lead are not a bar, the chief limitation has been the excessive thickness of lead alloy coating, usually about 5 per cent.

By increasing the tin content of the alloy to 25 per cent, it is possible to apply a coating of about 2 per cent total weight and in this way ½ lb. of tin plus 1½ lbs. of lead per basis box has been substituted for the usual 1½ lbs. of tin. This new type of terne is readily solderable and has been extensively adopted for oil containers and for many other purposes, the bodies of gas meters being a case in point.

Thin Coating of Tin Plate

It is probable, however, that in the tin plate industry tin will be found the most widely usable "substitute" for tin. The possible economy is, however, very real, as a thin electro-deposited tin coating can be used to replace the conventional hot-dipped coating for many purposes, without a too-great increase in corrodibility or decrease in solderability (see illustration).

The present trend is to replace the standard 1.5 per cent tin coating with ½ per cent electro-tin or less, combined with a protective lacquer. This quality of tinplate can be soldered, and is therefore amenable to the established fabricating operations. It is expected to possess sufficient resistance to corrosion to be useful under war-time conditions. Fortunately the technical difficulties of electro-tinning have already been overcome and the question is largely at what speed the new plants can be constructed in war-time.

In this instance the difficulty cannot be overcome entirely by adopting the American practice of continuous electro-tinning of cold-rolled steel strip. About two-thirds of all British tinplate is still produced by pack rolling, and it is therefore necessary to tin the individual sheets. The problem is being solved by an adaptation of the mechanical-handling plant originally designed for automobile parts.

One unit is already nearing completion which will pick up 10 sheets at a time, carry them through the plating and washing baths and deliver them at the rate of about 1,000 basis boxes per week. Such units have great flexibility, and various sizes of sheets and thicknesses of tin coating can be handled. This presents many advantages where a varied market has to be met in relatively small quantities with the greatest economy of tin.

Use of Tin-Lead Alloy

An analogous use of tin is the coatings applied to a wide variety of components and fabricated parts by immersion in a bath of molten tin. This is done for a number of purposes, appearance, protection against corrosion, provision of a surface suitable for contact with milk, foods, and so on; and quite often to facilitate a subsequent soldering operation. Except in the case of food-handling equipment it is usually possible to substitute a tin-lead alloy. Various compositions have been adopted.

So far the chief limitations appear to be a loss of smoothness and gloss. A tinning bath rapidly accumulates iron, copper, zinc and so on from the parts being immersed. In the case of the tin bath the resulting compounds sink and can be dredged out, but in the lead-tin bath the compounds float, get entangled with the flux, tend to adhere to the articles being dipped and in consequence the coating is somewhat rough. Nevertheless, the movement is going on, the coating of copper wire for cables being a typical instance.

One Antelope, At Least!

"How about this for an antelope!" says William C. Stewart of the Naval Engineering Experiment Station at Annapolis, Md. The photomicrograph was taken at 500X and the composition of the steel is given as: C 0.04, Mn 0.60, Si 1.00, Cr 25.0 and Ni 13.0 per cent.

An Arab or a Ski Trooper

To the Editor: While measuring the depth of decarburization in a specimen of 1 per cent Cr, 0.5 per cent C steel, I found what might be an Arab or a ski trooper asleep on sentinel duty at the border of the decarburized zone. The figure has so much resemblance to a human profile that I thought it eligible for "Chuckles."

J. ROBERT DOIG

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A FEW MICRO-LAUGHS

The Good Steed Steadite

To the Editor: Out here where there is plenty of open range one of our students in metallography was not surprised to get a glimpse of the good steed Steadite the other day when he was looking at a sample of ferritic cast iron. Pasturage was very poor as can be observed by the many ribs showing. Mag 500X.

This photomicrograph was prepared by Lloyd E. "Doc" Carlson, one of our seniors.

BANCROFT GORE

Professor of Metallurgy
So. Dakota State School of Mines
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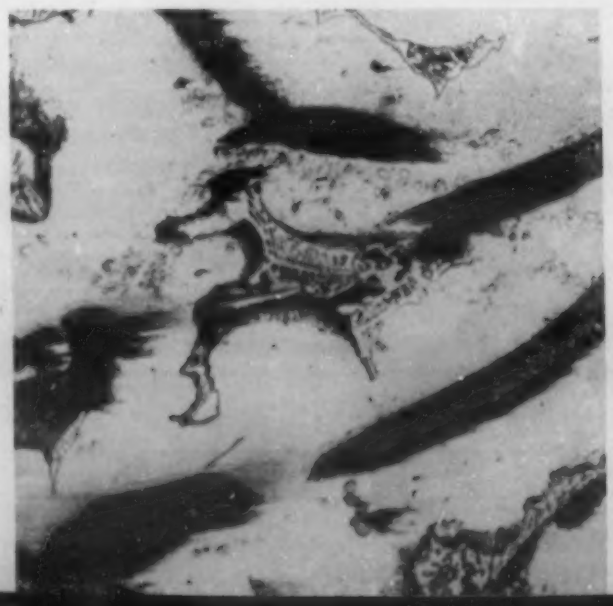


"Oscar of Powder Metallurgy"

While making a routine metallographic examination of a part made here at Moraine Products by powder metallurgy techniques of iron and carbon, we saw the "Oscar of Powder Metallurgy" shown in the illustration.

Believe it or not, Oscar is completely natural even unto his eye which has a strange and malevolent glint. Oscar's proud stature is undoubtedly due to the fact that he is housed in a truly superior bearing.

Oscar is used to only the best so please treat him kindly.

J. W. PRICE, Metallurgist
C. J. BIER, Metallographer

Moraine Products Laboratory, Moraine Products Div.,
General Motors Corp., Dayton, Ohio

METALS AND ALLOYS

Engineering File Facts

SHEET No. 1 — GENERAL ENGINEERING DATA

Introduction — Definitions, Abbreviations, etc.

With this issue, and on this page, we begin publication of a new editorial service — a continuing series of compilations and tabulations on materials and processes used in the metal industries. These "data sheets" will present up-to-date reference-type information on engineering materials and metal-forms for design and construction, and on the basic principles and procedures for carrying out the individual metallurgical engineering operations, together with generally useful data for *both* production and design men. Each "File Facts" sheet will be an original compilation, based on material-property data obtained from several sources and on actual reports of shop practice.

This engineering information will be grouped under three general headings:

1. General Engineering Data
2. Materials and Design
3. Processes and Procedures

Each sheet of this section will be titled and the subject indicated, so that it can be removed from the magazine and filed under the appropriate heading.

In order to conserve space and make these "Engineering File Facts" pages as concise and useful as possible, a number of specialized terms, abbreviations and symbols will be used.

The following list gives only the practical usage of some of these terms and abbreviations as they will be employed in compiling the technical information.

A few of these terms are:

Metal — A commercially pure metallic element.

Alloy — A metallic element to which other elements have been purposely added to improve the physical properties.

Ferrous Material — An iron-base alloy (substantially iron with other elements added). This term includes steels (iron with up to 1.7 per cent carbon content) and cast irons (1.7 to 5 per cent carbon).

Non-Ferrous Metals and Alloys — All those engineering metals and alloys containing no appreciable iron content, such as copper, bronze, zinc, aluminum and lead alloys, etc.

Non-Metals — The non-metallic engineering materials such as plastics, wood and others of commercial importance.

Symbols of Some Metals and Common Alloying Agents and Their Important Uses

Name	Symbol	Most Important Applications
Aluminum	Al	Chief constituent of aluminum alloys, the No. 1 aircraft material.
Antimony	Sb	Used in lead-antimony alloy cable sheathing and in bearing and type alloys.
Beryllium	Be	Alloyed with copper to make a heat-treatable alloy.
Bismuth	Bi	Used in solders, "type metal" and low-melting-point alloys.
Boron	B	An addition agent used in steelmaking to improve hardenability.
Cadmium	Cd	Alloying agent in some bearing alloys extensively used as an electroplated corrosion-resistant coating for metals and alloys.
Carbon	C	Makes steel hardenable.
Chromium	Cr	When alloyed with steel, it promotes deep hardening and corrosion resistant properties; also used as a wear- and corrosion-resistant electroplated coating for metallic parts.
Cobalt	Co	Used mostly in high-speed steel to promote "red-hardness." Also important in making cemented carbides.
Copper	Cu	Used for electric wire, or alloyed to form brass or bronze. As an electroplated coating it has many uses.
Gold	Au	Buried at Fort Knox.
Indium	In	Used as a bearing surface, as an alloying agent with lead, and as a protective coating.
Iron	Fe	The basis of steel and other ferrous materials.
Lead	Pb	Sheathing for telephone and submarine cables, and the basis for some solders and bearing alloys. Also used for acid-resistant purposes and in storage batteries.
Magnesium	Mg	Alloyed with aluminum to make the lightest structural alloy known. Used in pure powdered state for flares, incendiary bombs, etc.
Molybdenum	Mo	A strengthener for steels and cast irons; an intensifier of other alloys when used in steel.
Nickel	Ni	Used with iron, copper and/or chromium for heat-resistant and stainless steels. Also used in making tough steels. Important as an undercoating for electroplated chromium.
Silicon	Si	Important hardener in steel and bronze; also prominent in cast iron.
Silver	Ag	Used for coinage, silverware and electrical purposes. As an alloying agent in tin-free solders and bearing alloys it has a potentially wide field of usefulness, except in the eyes of certain Congressmen.
Sulfur	S	In small quantities it improves the machinability of steel.
Tin	Sn	Alloyed with copper to make bronze; also important to solders, bearing alloys and tinplate for containers.
Tungsten	W	The element that makes high-speed steel "high speed"; *i.e.* it promotes hardness at red heat.
Vanadium	V	Toughens and strengthens steels.
Zinc	Zn	Important as a pure metal (for corrosion-resistance uses and dry cell cases), when alloyed with copper to make brass, and as a basis for die castings.

Compiled by Robert S. Burpo, Jr.

Summary of Case Hardening Methods

What is case hardening? It is a process in which ferrous materials (usually low-carbon or "carburizing" steels) are heated in the presence of a solid, liquid or gaseous compound that will produce a hardenable surface (or "case"). Usually this means increasing the carbon content of the steel at the surface to such an extent that it will harden when quenched (this is called carburizing). By this method the easily machinable low carbon steel work-piece can be economically machined to size and then, in effect, have its surface changed to a high carbon tool steel that will, when quenched, have high hardness and wear resistance.

Definitions of a Few Terms Relating to Case Hardening Practice

Carburizing Steel: A low carbon steel, 0.15 to 0.25% Carbon. (Such as SAE 1020, 1117 or NE 9420), with low sulfur and phosphorus contents: manganese or other alloying agents may be present to improve certain qualities of the material.

Case: This is the artificially enriched surface (formed by carburizing or other case hardening methods) that is capable of being hardened.

Case Depth is the thickness of the case, and is measured microscopically as the depth of penetration of carbon and/or nitrogen.

Core: The unchanged soft interior of a case hardened part.

Cyanide Case: A thin case produced by soaking low carbon steel in a molten cyanide salt.

Salt Bath: A fused or molten (liquid) salt that can be used as a heating or case hardening medium (depending on the composition of the salt bath). Activated cyanide compounds will produce a deeper case in less time than is possible with the straight cyanide salts.

There Are Three Important Methods of Case Hardening

1. Carburizing with a solid or gaseous compound.
2. Nitriding.
3. Salt bath hardening.

Both the first and third methods must be followed by quenching from a suitable temperature in water, brine or oil to harden the carbon enriched case. A nitrided case requires no quenching.

Case Hardening With a Solid Carburizing Material

This is sometimes called "pack hardening." The steel parts to be carburized are packed with the crushed carburizing material surrounding them in an alloy heat resistant box. This box (containing the parts surrounded with the carburizing medium) is placed in a furnace, brought up to heat and held at temperatures a sufficient length of time to permit the building up of a carbon-rich case of the required depth.

The carburizing medium is a mixture of crushed wood or bone charcoal and an energizer (usually a carbonate). When heated, this material liberates carbon monoxide inside the box. The hot steel reacts with the carbon monoxide to produce a form of carbon that is readily incorporated into its surface, producing a high carbon case.

The commercial temperature range for this type of operation is 1650°-1750° F.

Because of the difficulties of accurately controlling the temperature inside the carburizing box, case depths of less than 0.025″ should not be specified for pack carburized work. Both time at heat and temperature govern the case depth; after 4 hrs. at 1700° F., a case of 0.040-0.050″ is obtained. 8 hrs. is usually ample time for bringing a box up to heat and producing a 1/16″ case (at 1700°). Box furnaces heated by oil, gas or electricity are commonly used.

After carburizing, the boxes are cooled and the parts removed and cleaned, reheated and quenched. Or, the parts may be removed from the box and quenched directly from the carburizing heat. This quenching of carburized parts (either directly from the carburizing heat, or slow cooled and re-heated) is necessary to harden the case, as it is soft (like a piece of annealed tool steel) when it is taken from the carburizing box.

Gas Carburizing

Gas carburizing accomplishes the same thing as pack carburizing. However, instead of packing the parts in a charcoal mixture, a carbon-rich gas is used as a carburizing medium. This method is superseding pack carburizing because of its cleanliness, ease of handling and better control.

Many types of carbon producing gases (or mixtures of gases) may be used: city gas, natural gas, propane or various proprietary gas mixtures. Or, the gas obtained from a volatile hydrocarbon liquid can be employed.

Whether a gas or a volatile liquid is used, the active carburizing medium is in the form of a gas. It is advantageous to agitate either the work-pieces (as in a rotary batch type furnace) or the carburizing medium (as in a horizontal continuous, or in vertical batch type furnaces) during the carburizing treatment. In the rotary type, the furnace rotates, thus agitating the work; a fan is employed to assure a uniform distribution of both gas and heat throughout both the continuous and vertical (bath type) furnaces. If no agitation of work or gas were provided, soot might collect on the parts, or an unequal distribution of heat and gas might result; in either event the case obtained would not be uniform.

The following table indicates the effect of time and temperature on average case depths obtainable: —

	Case Depth At		
Time at Heat	1500° F.	1650° F.	1700° F.
4 hrs.	0.015-.020″	0.030-.035″	0.035-.040″
8 "	0.020-.025″	0.040-.045″	0.050-.055″

Nitriding

Nitriding is a somewhat different process than gas carburizing in that, instead of a hydrocarbon gas, ammonia is used to furnish nitrogen to the case. The nitrided case is a very hard, relatively shallow skin formed by the union of nitrogen (from the dissociated ammonia) and iron (present in the steel). Such a case requires no quenching; it is very hard when the part is cooled to room temperature.

Another outstanding difference between gas carburizing and nitriding is that the nitrided case can be formed at relatively low temperatures (930 to 1200° F.). Some multiple stage heating cycles are used for nitriding, such as heating to 950-1000° followed by increasing the processing temperature to 1150-1200°.

The time at heat is much longer for nitriding than for other case hardening processes. A period of 20 hrs. at 975° F. is required to produce a 0.012″ case, and 60 hrs.

will give a case depth of 0.020-.025". Since a nitrided case is so much harder than a carburized and quenched case (80-87 Rockwell 30N against 66-71 Rockwell 30N for carburized cases) a deep case is unnecessary.

Because of the low reaction temperature and freedom from quenching, the distortion and oxidation of nitrided parts is very small.

Special analysis steels, heat treated prior to nitriding give the best results.

Nitriding furnaces usually are of the batch or semi-continuous, electrically heated bell type.

Salt Bath Hardening

The salt bath process of case hardening is one where the work is submerged in a fused salt. In its most widely used form, this salt is a mixture of sodium cyanide and some other sodium and barium salts. This type of salt is known as an "activated" cyanide as distinguished from the older cyanide bath containing only molten sodium cyanide. By varying both the proportions of the various compounds in the salt and also the operating temperatures, baths can either produce a cyanide case, or a predominantly carbon or nitrogen rich case.

The salt bath method is a clean, quick way to case harden small parts. After quenching, some of the newer deep carburizing salts will form the following case depths:

Time At Heat	Case Depth At			
	1600° F.	1650° F.	1700° F.	1750°F.
2 hrs.	0.015-.020"	0.020-.025"	0.030-.035"	0.035-.040"
4 "	0.025-.030	0.030-.035	0.045-.050	0.055-.060
8 "	0.040-.045	0.050-.055	0.065-.070	0.080-.085
16 "	0.055-.060	0.070-.075	0.100-.105	0.120-.125

Proprietary salts are also sold especially for light cases (up to 0.010") and for medium depths (to 0.030"). At the lower processing temperatures (around 1500° F.) the case will contain a greater proportion of nitrides than if heated to 1650°-1750°. The combination (cyanide) case tends to be harder than a straight carburized and hardened case, and also the wear resistance of such a case is quite high.

In addition to case hardening various parts in activated cyanide, another important use of this type of molten salt bath is for heating previously gas- or pack-carburized or deep hardening steels for quenching. By so doing, the part (whether it has been carburized or is a deep hardening steel) is heated to the quenching temperature in the presence of the cyanide-case-producing material. This develops a very thin case as the heating time is short compared to that required for case hardening. Also, any tendency towards decarburization is counteracted or prevented by the carburizing action of the salt bath.

When these steel parts are heated in this manner and then quenched, the thin hard skin formed by heating in the salt bath is reinforced by the hardenable steel below it. This combination is excellent, especially for gears, where resistance to scuffing and abrasion is very important. Tools that are subject to excessive wear have their useful life prolonged considerably by such a case obtained when they are heated for quenching in a salt bath.

In addition to steel parts, cast and malleable iron parts are often case hardened in a salt bath.

Salt bath furnaces (called "pots" in smaller installations) may be made of ceramic or ferrous materials and can be heated by gas, oil or electricity. In several modern installations designed for uninterrupted operation, the heat is furnished electrically by immersed electrodes.

Miscellaneous Case Hardening Methods

The "Ni-Carb" or "dry cyanide" process employs both carbon-rich and nitrogen-rich gases, producing a case very similar to that obtained with activated cyanide. Quenching is required, as in the salt bath process. Very careful control of the gases used in this process is essential.

Another combination process is one in which dissociated ammonia is bubbled through a molten activated cyanide bath. This combines some of the features of a cyanide case with the nitride case. Very close control of this process is also advisable.

A case produced in this manner is obtainable at a lower temperature than either a carburized or activated cyanide case (at approximately 1500° F.) and is somewhat harder than either of these.

As with salt bath case hardening, both cast and malleable iron parts can have their exposed surfaces hardened as well as steel parts.

Why Case-Hardening is Used

In general, case hardened parts are used for two reasons. First, the case hardening steels, being low in carbon and alloy content, are easily machined. The machinability of case hardening steels is compared with some of the deeper hardening materials in the following table.

	Steels	Machinability
Case-Hardening Steels	SAE 1020	60%
	SAE 1117	90
	NE 8024	74
	NE 8620	74
Deeper-Hardening Steels	SAE 1095	45
	SAE 6150	50
	SAE 3250	44
	Oil Hardening Tool Steel	30

Because of this property the machining of parts made from low carbon steels is less expensive and time consuming than if the same part were made from the high carbon or alloy steel. The second important reason for the use of case hardening parts is that the hard case is backed by a ductile core and therefore is much more shock-resistant than one that has been hardened all the way through. In addition, the resistance to wear and to fatigue of a properly case hardened work-piece is greater than if it were made of a deeper hardened steel.

The reasons then for case hardening of steel parts may be summarized as follows:

1. Improved machinability.
2. Greater shock and wear resistance as compared to many of the hardening materials.

This resumé of the important principles and methods of case-hardening is necessarily very brief. However, in future pages of Engineering File Facts, each of these case-hardening processes will be discussed individually and more completely.

Compiled by Robert S. Burpo, Jr.

SHEET NO. 3

MATERIALS AND DESIGN
Metal-Forms

Comparison Of High Production Methods For Small Parts

In this compilation of the relative properties of certain materials for small parts, the rating system employed is one where "1" indicates the most desirable rating. In the cost features, for example, the rating of "1" indicates the lowest cost. A similar rating in the case of a design feature indicates the most favorable rating.

This table of comparisons is designed as a guide or quick reference to the engineering aspects of some metal forms. Hence, specific circumstances (such as very high or low rates of production, limitations of existing equipment, etc.) may alter the relative positions of some of these items.

Characteristic Compared		Zinc Alloy Die Castings	Gray Iron Sand Castings	Steel Stampings	Steel Screw Machine Parts	Molded Phenolic Plastics
Relative Cost and Production Features	Production Speed	2	5	1	3	4
	Machining Cost After Casting	1	3	—	—	2
	Tooling Cost	4	2	5	1	3
	Cost of Applied Finish	2	3	1	2	1
	Cost of Materials per lb.	3	1	2	2	4
	Scrap Loss	1	2	3	4	1
Relative Design Features	Flexibility of Design	2	1	4	5	3
	Feasibility of Designing Part as 1-piece unit	1	2	3	3	2
	Maximum Size of 1 Piece	3	1	2	5	4
	Ease of Holding Close Dimensions Without Supplementary Machining.	2	5	3	1	4
	Accuracy in Cored Hole Size and Location	1	3	—	—	2
	Surface Finish Without Special Finishing Operations	2	3	1	1	1
	Ease of Attaining Good Finish	1	4	2	3	1
	Feasibility of Producing Parts with Thin Sections	2	3	1	2	2
	Weight per Piece of Same Size	3	4	2	4	1
	Weight per Piece of Equal Strength	4	5	1	2	3
	Tensile Strength of Material	3	4	2	1	5
	Relative Impact Strength	2	3	1	1	4
Actual (Average) Physical Properties	Tensile Strength, psi.	40,000	25,000	54,000	87,000	6500
	Elongation in 2 inches, %	2	—	20	17	0.6
	Hardness, BHN	78	170	123	183	38
	Specific Gravity	6.7	7.2	7.8	7.8	1.4

Compiled by Robert S. Burpo, Jr.

(Editorial continued from page 315)

we should be to forget this, our real war aim, particularly since keeping it like a beacon before us while we fight can be one of our most effective spurs.

It will be a long war, indeed! But the peace — the industrial hereafter — is *worth* fighting for, long and hard. And if it's worth fighting for, it deserves a bit of planning as well.

So, take a part of "Sunday afternoon" regularly and do some constructive thinking about this hereafter. Think of it in terms of your country, your family, your industry, your plant, your products or just yourself — any way you please — but think! And we'll provide an occasional vicarious stimulus. —F.P.P

Onward March of Electric Steel

There are several important features of the production records of the American steel industry in 1942 but the most spectacular one was that of the electric steel industry. Its expansion was truly remarkable.

The total output was 3,974,368 net tons, a new record, according to preliminary statistics of the American Iron and Steel Institute. This is an increase of about 41.5 per cent over the 1941 total of 2,809,256 tons. The capacity of this industry on Jan. 1, 1942, was 3,737,510 tons. Therefore the output last year exceeded this rated capacity by over 236,800 tons, indicating that the industry had been expanding during the year. On Jan. 1, this year, the capacity was probably somewhere near 4,400,000 tons and still expanding.

About 30 to 35 years ago the electric furnace came into the picture. According to a survey of the world's electric furnace industry, published in "The Iron Age," April 14, 1910, there were then only 10 such furnaces in the United States. This had expanded to 19 in 1913. Today the number runs into the hundreds with definite data unavailable.

Looking back over the years it is evident that the growth of the electric steel industry has been largely at the expense of the crucible as a melting medium. In those earlier years the bulk of the fine tool steels were made in crucible furnaces.

In 1912 and 1913 the crucible steel output of the country was about 120,000 to 125,000 tons per year, with the production of the electric furnace only a small fraction of this. Today the position is decidedly reversed—the latest data show that in 1941 only 2,313 tons of crucible steel were made with only 1,024 tons in 1940. Thus the electric furnace now supplies not only most of the tool steels but also a large share of the high-grade special alloy steels.

The data here being considered do not include the steel casting industry where the electric process is a large factor in making cast armor plate and other castings for war implements. Recognition of this would considerably swell the total output.

Of course war demand is the main cause of these records in output, but even after the war is over the relative position which the electric steel industry has attained will not be greatly impaired though the tonnage produced may decline. The electric furnace, regarded with some skepticism when first introduced, has firmly established itself as an indispensable unit in the production of high quality and complex steels. —E. F. C.

METALLURGICAL ENGINEERING shop notes

New Way of Shrinking Galvanized Plates

By Al Lake,
Albina Engine, Machine Works & Shipyard

We have developed in our shops a new method of shrinking galvanized plates without burning and without poisonous fumes. Under the old method, burning of galvanized plates was severe and frequently so weakened the plates that they had to be replaced. Fume sickness in some war industries takes a toll as high as 40 per cent. Formerly, plates were roughened and needed sanding to smooth the burned surfaces for the painters. This is now dispensed with. Moreover, 50 per cent of the cost of ventilating systems has been eliminated and respirators need no longer be used.

The new method requires no new equipment. The flame is a highly oxidized one — about 15 lbs. of oxygen to 10 lbs. of acetylene to start. The torch is lighted with a neutral flame (oxygen 1.05, acetylene, 1.00). The flame is then starved at the torch by turning down the acetylene valve. Original pressure is maintained in the hose, the starving of the flame of acetylene "cooling" it.

The torch tip, an 11-hole tip — 10 holes in a ⅜ in. radius with one hole in the center (holes made with a size 60 drill) — is held from ¾ to 1 in. from the galvanized surface. The flame is held steady until the metal is cherry red and a barely perceptible "flowing" is noted on the surface of the heated spot. Withdrawal of the flame at the correct moment can be learned only through experience.

Spots are made about 1 in. apart. Water from the water-quenching ring must be kept flowing constantly. A highly carbonized flame does away with fumes and burning, though it does not give nearly so clean a job. Work has been done on metal plates up to ½ in.; when thicker, it is better to use torches on each side of the plate, men working on opposite sides of the same spot.

In the accompanying photograph the old method was used at the dark spots; the new, at the light spots.

Induction Hardening for Ball Mills

by Seward A. Covert
Ohio Crankshaft Company

Doubling the life of steel balls or cast iron slugs in ball mills can be accomplished by induction hardening, such as the Tocco process. Ball mills have extensive use in cement mills for grinding, but are also standard equipment in grinding ores, paint pigments, plastics, resins, etc.

Slugs experience excessive wear during grinding. Frequently they crack, thereby clogging the ball mill meshes, or they pit, thus becoming coated with cement and ruining their grinding ability.

In a cement mill, inductivity-hardened slugs showed a loss by wear of only .06 lbs. of steel per barrel of cement as against .13 lbs. lost by slugs hardened by older methods.

Capacity of a typical induction hardening machine can be as high as 5000 slugs per hour. Slugs pass through an inductor coil on a roller feed and are immediately quenched in the same unit after heated to the proper degree.

A cement ball mill is a large steel cylinder having a capacity of several tons of clinker cement, plus grinding media. Set with one end higher than the other, the mill rotates to agitate the media and material within. Through the rolling, pounding and grinding of the slugs, the lumpy cement is pulverized.

Because of the scarcity of steel, which has caused some experiment with pebbles, anything that causes longer life is desirable. It is estimated that it would save 5700 tons of steel in the cement industry alone.

Forgings Lessen Scrap Losses

by Raymond M. Seabury
Drop Forging Association

An important safety factor of the Barrett hydraulic lift truck, which moves loads of 5,000 lbs. or more, is the forged spring guide, designed to stand up under 24-hr., 7-day week plant schedule.

Formerly, a welded type of construction was employed for this spring guide, but considerable breakage occurred. A change over to a forged part where the head is forged integral with the shank proved advantageous in several respects.

Scrap losses were lessened as practically no rejections resulted, because with forgings it is possible to obtain uniformity of physical properties to the exact degree desired. Other gains were: 50 per cent increase in number of guide bars finished per hour; inspection totally eliminated; manufacturing cost reduced 30 per cent.

The guides are forged from SAE 1045 steel and heated to Rockwell hardness of C-28-37. The forged guides have been produced over seven years and the maker says: "We have yet to see a broken guide."

Arc Welding Worn Brake Heads

By J. D. Seivewright,
528 St. Clair Ave., W. Toronto

(From a paper presented in the $200,000 Industrial Progress Award Program of the James F. Lincoln Arc Welding Foundation, Cleveland.)

At one depot of the Canadian National Railways, Central region, an average of 1800 brake heads per month are reclaimed by electric arc welding at a cost of only 9.1 per cent of the original cost of a new brake head.

Brake shoes on railroad cars require renewal frequently. These shoes fit into a malleable iron casting known as the brake head, where they are held in place by a tapered steel key driven in a hole in a lug cast on the back of the shoe.

Considerable wear occurs in the recesses of the brake head into which the projections of the shoe fit. Many brake heads were being scrapped annually because of this wear.

We decided to build up the worn surfaces with steel deposited by the electric arc process of welding. The deposited metal provides a better wearing surface and longer life than obtained from the original casting. The welding machine is a Lincoln 200 amp.; electrodes are of the same type as Fleetweld No. 7, 1/8 and 5/32 in. in diam.

Brake heads are collected from shops and repair tracks over the Atlantic and Central regions and sent to the Central reclamation depot, where they are sorted.

Only two of the three regions of Canadian National Railways have adopted the system, but the third will shortly when total reclaimed heads should be 32,400, a saving of $35,640 annually.

The estimated saving per brake head, based on 1000, is arrived at as follows:

Labor	
100 hrs. @ 86c	$86.00
Material	
S.A. Welding Electrodes — 190 lbs. @ 11c per lb. *20.90*	$106.90
Store Expenses	6.41
Total	113.31
Cost for one reclaimed Brake Head	.11
Cost of new Brake Head	1.21
Saving per Brake Head	1.10 or 90.9%

Estimated saving per annum for Atlantic and Central Regions — $23,760.00

#1

#2

#3

#4

#5

Brake heads fit for reclaiming are placed in a pile (Photo No. 1). Welding is performed on a bench on which is a supporting device holding five heads. Here accessible surfaces are welded. They are then turned over and the operation completed on the opposite side (Photo No. 2). Built-up surfaces (small arrows in Photos No. 3 and 4) need no grinding. Reclaimed heads are assembled on brake beams in the same manner as new heads and with no preference when applying them to brake beams (Finished beams appear in Photo No. 5).

Quenching Shell Steels

by E. E. Carpenter,
E. F. Houghton & Co.

To conserve alloying elements and still attain needed physical properties, the rate of quenching shell steel must be accelerated. Studies have been made, too, of quenching temperatures. Some have attempted as low as 100 deg. F.; others ran their oils at 180 deg. F. But a compromise and standard practice has been reached at 130 to 140 deg. F. with adequate agitation and spray jets for quick heat transfer.

After much research, correct quenching oils have been assembled. The best formula will include a percentage of wetting-out agent added to the mineral oil, which lowers interfacial tension and speeds spreading of oil over the metal surface.

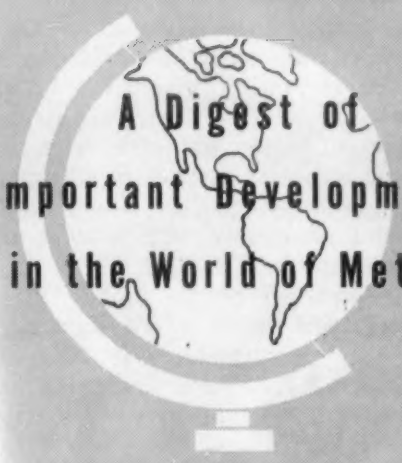
After the metal is well wet-out, it is necessary to have a high degree of heat absorption to enable transfer of the heat rapidly from the steel to the oil. The ideal oil should contain a stabilizing agent that minimizes oxidation, or fractional distillation of the oil in service.

A large automotive plant tested two oils: One a straight mineral oil and the other an oil containing additional ingredients and with characteristics described above. Steel used was an SAE 1045 type. A specimen 1¼ in. round by 4 in. long was quenched from 1550 deg. F.

Brinell hardness readings were taken at the outside of the specimen and at the center after the quench. The all-mineral oil produced a hardness to 363 at the center; the modernized oil, however, produced almost identical hardness at the outside and center of the test piece.

Firms who in civil life had been making pumps, motors, diesels, automobiles, washing machines, etc. had had no experience with instruments of destruction such as shells, armor-piercing shot, mines and bombs. Such concerns especially should buy intelligently their quenching oils.

Metallurgical Engineering Digest



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Antimony

Condensed from "Metallurgia"

Antimony is one of the oldest known minerals. In the first century and earlier it was employed as a hair dye and eye-enlarger. It was used medicinally as an emetic and today the Arabs and Hebrews know it as "kohl." Its form for these purposes is the sulphide mineral "stibnite." In the sixteenth century, it was used in making printers' metal, mirrors and bells and earlier its sulphide was employed for separating gold and silver, as well as silver and iron.

Sources of Antimony

The main sources of antimony are stibnite, valentinite or antimony bloom, senarmontite, cervantite, stibieonite, kermesite, and native antimony. There are many antimonides of silver and other elements of metallic type and a series of intricate sulphides and oxides. In nature antimony is found in alliance with arsenic, nickel, bismuth, lead and tin.

The principal ore is stibnite which is seldom found below a few hundred feet. In 1938 it was produced in 26 countries of which Bolivia was first with a production of 9,287 long tons and the United States eighth.

Antimony itself is one of the group of elements containing nitrogen, phosphorus, arsenic and bismuth. In metallic form it is silver-white, crystalline in structure, brittle and has a metallic sheen. In chemical characteristics it has affinity with arsenic but in other respects it resembles the metals zinc and germanium.

There are no exceptional problems in mining antimony. Some deposits are worked open cast. In China, with the exception of a few mines where modern machinery is being installed, methods are primitive.

Stibnite is so soft and friable and so light in weight that methods of water concentration are not economical, unless the ore contains high percentages of precious metals. Antimony sulphite can be concentrated by flotation. Creosote oils with sulphuric acid produces the greatest recovery percentages at least expense. In Southern Rhodesia refractory antimonial gold ores are water-concentrated, and oil-flotation follows.

Making Metallic Antimony

There are six ways of producing metallic antimony. The first, used for ores with more than 40 per cent and less than 90 per cent sulphide, is liquation to crude antimony. Intermittent liquation is carried out in fireclay crucibles placed vertically in rows in an open fire, with brick walls separating the rows. The liquid sulphate falls through holes in the bottom of the crucibles into a receptacle of burnt clay.

For continuous operation, tube furnaces, vertically located above receivers, or reverberatory furnaces with a tap hole in the deepest point of the bed are used. Liquation is wasteful because as much as 15 per cent antimony is left in the residues.

To produce from rich stibnite, the ore is placed in crucibles made of a mixture

One New Ramix Bottom..Six More Destroyers

LAST JUNE a Ramix bottom was installed in a 130-ton open hearth. It replaced an old magnesite-and-slag hearth installed in 1926.

Complete records are available on both bottoms—so it is possible to compare accurately the cost of these two types of hearths. Refiguring the magnesite-and-slag job at June 1942 material, labor and fuel rates, the use of Ramix saved this company $1,267.81 in out-of-pocket expense.

But more important to a shop engaged in war production is the time saving. The Ramix hearth took only 120 hours to build, heat up and make ready to charge the first heat, compared to 397 hours for the conventional burned-in hearth. At $60 an hour, the value of this time saving is $16,620—a total dollar saving of $17,887.81, thanks to Ramix.

More vital still, in the 277 hours of time saved, the furnace made 3,047 tons of prime steel. That's enough extra steel to build six more destroyers to help our boys win back the Solomons—or a hundred tanks to win the fight for Tunis.

Basic Service Engineers are always glad to help any steel manufacturer install Ramix hearths, make major repairs, or assist in solving any problem involving the use of basic grain refractories.

BASIC HEARTH

REFRACTORIES

BASIC REFRACTORIES, INCORPORATED

843 HANNA BUILDING ● CLEVELAND, OHIO

Ramix is manufactured in Canada, for sale outside U.S.A. and Mexico, by Canadian Refractories Limited, Montreal

of fireclay and plumbago on the bed of a long reverberatory furnace. From liquated sulphide, the sulphide is reduced by wrought-iron scrap. Common salt and liquated sulphide are added to the metal thus produced to form "star bowls." These mixed with the antimony flux and liquated sulphide form "star" antimony, commercially termed "French metal." Total loss from volatilization is 10 per cent. The fume is collected in condensing chambers.

Poor ores are treated by volatilizing roasting in a furnace built of fire-brick. The top of the furnace communicates with chambers furnished with condensation pipes, beyond which is a coke-tower. Water from this lays down the final traces of uncondensed oxide. The charge of 50 kgs. of ore with 2 kgs. of charcoal is roasted at a maximum temperature of 400 deg. C. (752 deg. F.) yielding in oxide at least 90 per cent of the contained metal.

Antimony oxides are reduced, in small reverberatory furnaces linked to a condensing system, by carbon in the presence of alkaline fluxes. The metal is generally refined in crucibles or a reverberatory furnace.

Direct processes for low grade ore comprise smelting in a blast furnace with a tall shaft and suitable condenser. Stibnite, slag and liquation residues with 25 to 40 per cent Sb can be so dealt with.

Commercial Uses

Antimony has many commercial uses. Precipitated from an acid solution by metallic zinc, it is used to give a metallic appearance to pottery, paper maché, other metals and gypsum. Some sulphides are used for rubber coloring and vulcanization, for safety matches and vermilion, orange-red and orange-yellow paints. They also line lead chambers for making sulphuric acid and make yellow and blue pigments.

Antimony oxides are used in the manufacture of enamels; as a coloring agent in glass and pottery; in the preparation of artificial gems; as a pigment for hard porcelain, stoneware or glazed earthenware; as a water-resisting white paint. Blends of oxide and sulphide provide yellowish-red and dark-brown pigments. Antimony sulphide and dry carbonate of soda give a brown-yellow pigment.

Antimony salts are used as mordants *e.g.*, tartar emetic, for dyeing, thickening and decolorizing and an emetic in medicine. Liquated antimony sulphide is used in the priming caps of explosive shells. In the shells themselves it is used to give off a thick white smoke as an aid in range finding. Sugar of antimony is used in furniture polish and "antimony butter" is a fireproofer *e.g.* creosote, pitch, tar and asphalt. Antimonic acid is used in aniline manufacture.

Antimony Alloys

Alloys of antimony include valuable metals such as the Britannia metal alloys, bearing or anti-friction metals, metals used for printers' type, hard or antimonial leads and various alloys of less importance. The principal metals with which antimony is alloyed are tin, lead, copper, zinc, bismuth and sometimes gold for jewelry. Antimonial leads are used for making shrapnel bullets, sheets for acid chambers, battery plates and chemical acid-resisting cocks and valves. This material is a by-product of lead smelting.

—L. Sanderson, *Metallurgia*, Vol. 26, Nov. 1942, pages 3-4.

Diamond Dies for Wire-Drawing

Condensed from "Metal Industry"

Fine wires are produced by elongating the metals from a larger diameter by drawing through wire-drawing dies. Tungsten filaments in general service lighting lamps vary in diameter from 0.00055 to 0.00187 in. Molybdenum wire used in radio receiving tubes of the most common types varies in diameter from 0.0012 to 0.008 in. To reduce the diameter of a tungsten wire from 0.04 to 0.0004 in. the wire has to be passed through about 75 different dies.

The diameters of these wires must not differ from an objective size by more than plus or minus 1 per cent and must not vary locally along the wire by more than plus or minus ¼ per cent. Diamond dies are used because they retain their size and also a high polish which makes it possible to pull the wires through with a small load.

Before the war fine dies, below 0.0002 in. in diameter, were imported from the continent. The General Electric Co., Ltd., has now designed machines with which female operators can produce the finest dies after 3 to 6 months experience. Fifty

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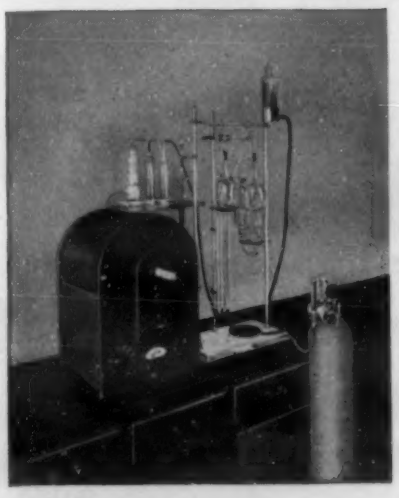
CARBON DETERMINATION



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drilling machines are now installed and a production of these dies is available.

Lowest quality diamonds are broken down into powder and then screened through 400 mesh sieves. Further grading, which formerly was unsatisfactorily done by the long process of suspending in olive oil, is now done with centrifuge. Five closely graded batches can be completed in half an hour. Either before or after grading, the powder is chemically treated to remove foreign material. Sometimes the loss in weight is 12 per cent. The resulting fine grade of powder has improved cutting or drilling properties.

Preparing the Diamond

Before a diamond is drilled, two parallel faces are cut and polished. In small dies one or two windows are cut and polished at right angles to the faces. To do this, several diamonds fastened into holders are held against a rotating disc of cast iron impregnated with diamond powder and spinning horizontally at a speed of about 2,500 r.p.m.

Special devices, fitted to the holders, make it commercially possible for girl operators to cut the two faces parallel to a fairly high degree of accuracy.

An apparatus has been designed primarily for the process of centering and rough boring the exit. It is a specially designed microscope. The essential feature is a stage fitted with adjusting screws so that the diamond can be placed in any desired position under the cross wires seen in the microscope field.

After marking the exact position to be pierced on one of the faces, the diamond is cemented with shellac to the specially shaped steel disc which fits into the stage. The mark is then centered so that when rotated it remains in the center of the cross wires. The stage is turned through 90 deg. from vertical to horizontal and coupled to a fractional horse power motor with foot-operated speed control. A small lamp throws light through the axis of the apparatus.

The point of a splint of diamond, held in the jaws of small pliers, is pressed on the rotating face of the diamond, to make a small countersink. The operator observes through a low-power lens.

Centering the exit has to be done with highest precision. The diamond is mounted with the side already drilled facing down and centered to the base of the hole. The exit is bored to two-thirds its finished depth by a diamond splint and completed on a drilling machine where the two holes can be united with sufficient care to avoid splintering.

Drilling

The diamond is kept in vibration and driven by a light spring against a revolving needle point. The vibration brings new powder, the actual means of drilling, to the needle point where it is driven against the bottom of the hole. The needle serves only as the carrier for the powder and to keep the hole correctly shaped.

In the new machine, a microscope aids the operator in maintaining the correct alignment of the needle and the diamond. Also the design permits the control of the ratio of the time during which the needle is in contact with the diamond, to the time for which it is withdrawn, to allow the powder to move below the needle point.

A micrometer screw feed presents the diamond to the needle point and arrests the forward travel of the diamond after the useful point of the needle has worn away. A subsidiary fitting enables the operator to shape and size the needle under the microscope without disturbing its alignment.

The drilling process is usually carried on in three stages with three grades of powder. The principal object in view is economy in drilling time. When the hole is less than a thousandth-of-an-inch in diameter, the particles of powder are usually of the order of two ten-thousandths-of-an-inch in size. Under these conditions drilling is very slow and the needle requires attention about every five minutes.

At the present time the drilling of a hole from 0.005 to 0.003 in. in diameter may take 12 to 15 hrs. and one operator can attend to six or more machines whereas drilling the finest dies from 0.001 to 0.0004 in. will take from 90 to 130 hrs. and the operator can control only three or four machines.

Polishing

Polishing the hole is done with fine steel needles and diamond powder. The needle must, in order to reach all parts of the hole, be directed in at an angle to the die axis. With dies greater than two-thousandths-of-an-inch in diameter machines of traditional design, with improved details, are used.

Development work on polishing fine dies is still in progress. At the moment it is carried out on the type of machine used for the drilling operation.

Close grading of the powder plays an important part in the degree of polish obtained. The time taken depends upon the smoothness of the drilling.

Mounting

The diamond is mounted in a metal case, a disc approximately one inch in diameter and a quarter to three-eights of an inch in thickness. Steel is the most suitable metal for drawing wires at elevated temperatures.

It is secured into a hollow in the center of the disc, with a suitable metallic alloy. This must be capable of holding the diamond securely for long periods at temperatures as high as 700 deg. C. (1292 deg. F.) The die must be mounted with the hole placed centrally, and its axis at right angles to the plane of the case.

A machine has been developed to increase the precision of mounting. The case is rested on a heat insulator and the diamond located by means of two tungsten needles, one in the top and the other in the bottom of the hole. A pellet of brass alloy is placed on the diamond and it is heated until the latter is plastic. The heat is turned off and the alloy pressed until it fills the hollow in the case. It must surround the diamond perfectly since excessive temperature damages the polished surface. When cool, the entrance and exit of the case are opened out to form a

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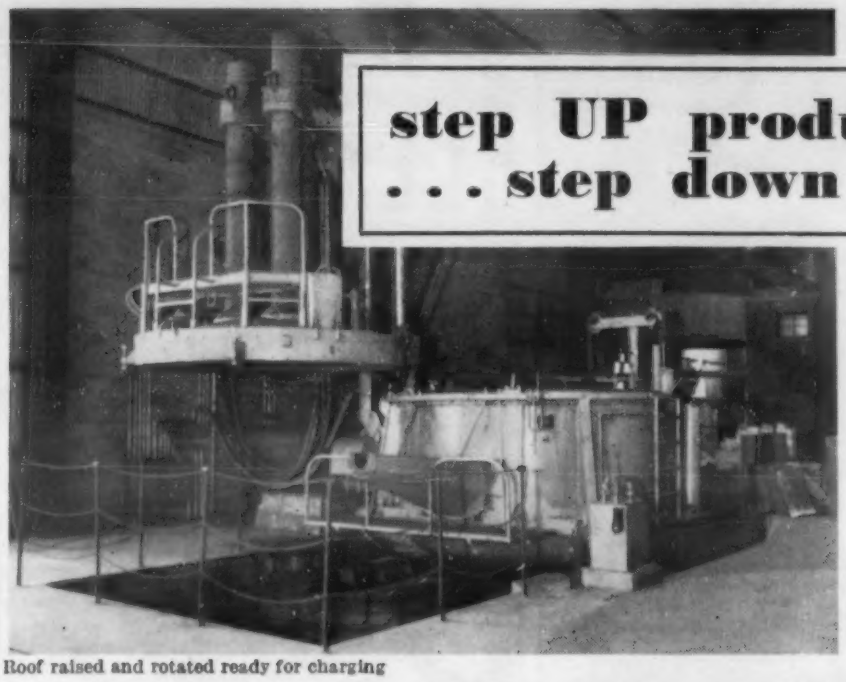

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MOORE RAPID *Lectromelt* FURNACES

the pig-iron is added. Generally, less scrap and pig-iron are used, make-up metal being provided by extra sinter.

Graphite can be added to pig iron in reboiling a soft heat. It is also employed for recarburizing rimming steels in the ladle.

As a Refractory and Coating

Graphite is an ideal super-refractory ingredient under molten steel and slag, although it has not been used extensively in refractory brick mixtures, or where direct flame impingement is involved. Virtually none of the graphite mixed with clay and broken brick is lost by solution in molten steel, although it does oxidize slowly in air at a red heat.

A runner lined with a graphite mixture will always last more than 10 heats and as long as 30 heats on high-carbon steel. Ladle bottoms lined with graphite mixtures over the brick will outwear the sides 2 to 3 times. A 70-ton ladle is the largest thus far lined in this way.

Another important application for graphite is for coating ingot-molds and preparing them for easy stripping. Only pure graphite is used for this purpose. Both spray and dip coatings are employed.

A heavy graphite slurry is used on stools, especially where high-carbon and high-silicon steels are poured. A thick paste about 60 degrees Bé is made up and swabbed on to the surface of the stools before setting the molds.

—R. J. Zemanek, *Steel*, Vol. 111, Nov. 16, 1942, pages 98-99, 101; Nov. 23, 1942, pages 86-87, 89.

continuous contour with corresponding portions of the hole in the diamond.

The size of the wire drawn through the die may be measured either with micrometers, electrical resistance or by weighing a known length of wire and calculating its diameter from the density of the metal concerned.

—B. P. Dudding, C. G. Eden and R. E. Leeds, *Metal Industry*, Vol. 61, Nov. 6, 1942, pages 290-293.

Graphite in the Open-Hearth

Condensed from "Steel"

Mexican graphite with a grain size between ¾ in. and 30 mesh is used in the basic open-hearth furnace and is designed to supply carbon steadily throughout the heat. It is charged beneath the lime and steadily feeds carbon from around the edges of the lime with enough being retained to provide sufficient carbon to hold a good melting curve when the slag is being shaped up during the working period.

Particles over ¾ in. will remain undissolved and float on the slag surface, gradually burning, while particles smaller than 30 mesh will dissolve too readily to provide a steady feeding of carbon throughout the heat. Maximum moisture content of 1 per cent is recommended.

Additions to the Charge

In calculating the amount to use in the charge, 1 lb. of graphite is allowed for replacing 15 lbs. of pig-iron. For example, instead of 30,000 lbs. of pig-iron, 2000 lbs. of graphite and 28,250 lbs. of scrap would be used to provide the required amount of iron. This is based upon the silicon and manganese content of the replaced pig-iron as well as its carbon content.

The graphite is placed upon the top of the loaded charging boxes containing limestone. Usually half the required quantity is charged through the center door and the remainder equally through No. 2 and No. 4 doors of a 5-door furnace. It is safe to place the graphite directly on to the furnace bottom, as it is inert to basic reactions.

Mexican graphite contains no sulphur or phosphorus. It aids reduction in phosphorus by replacing high-phosphorus pig-iron. It lessens sulphur problems when used in place of coke. Its use results in non-foaming heats where these have been caused by more porous, light, reactive coke.

Graphite has been used to supply carbon where excessive amounts of iron ore or sinter are charged to obtain extra metal. It is charged by placing the bags on top of the loaded boxes of sinter. When these are overturned into the furnace, the graphite is sandwiched between the sinter and limestone. The carbon, being next to the ore, can help in the work of reduction.

Advantages in this application include resistance to rapid direct action with the iron oxide at elevated temperatures, allowing it to dissolve into the melting scrap and gradually enter into the reaction after

Hardenability Control at the Mill

Condensed from an American Society for Metals Paper

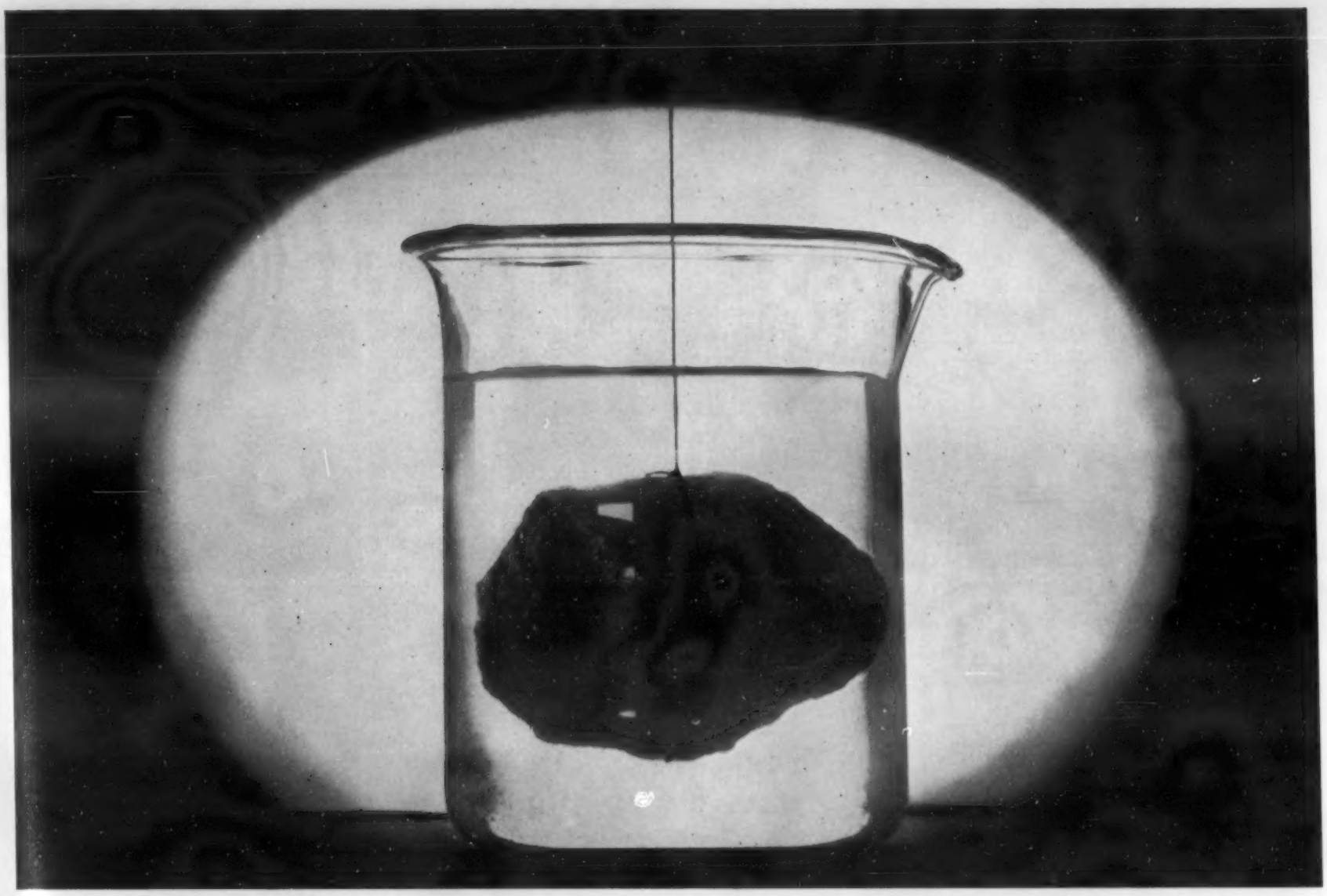
Hardenability control and correlation of hardenability with chemical composition have been popular topics for recent articles. Usually the work has been done on a relatively small number of steels, either experimental melts or heats picked at random. Therefore, a paper based on more than 600 electric furnace heats all made with the same deoxidation practice and general melting procedure is unusually welcome.

The carbon was constant at 1.00 to 1.03 per cent. The rest of the analysis varied as follows:

Mn + Si + Cr + Ni	Hardness Penetration in in. (1 in. rd.)
0.70 — 0.80	0.120 — 0.140
0.85 — 1.00	0.150 — 0.170
1.05 — 1.15	0.190 — 0.210
1.15 — 1.25	0.210 — 0.230
1.25 — 1.35	0.230 — 0.250

Manganese additions to the heat were varied so that a definite sum of Mn + Si + Cr + Ni was obtained, depending on the required hardenability range; thereby, the variable residuals were compensated for. McQuaid-Ehn grain size was coarse, but fracture grain size as quenched from 1430 deg. F. was uniform and averaged No. 7.

For the hardenability test, 1 in. rd. samples were normalized from 1600 deg. F., then brine quenched from 1430 deg. F. The hardness penetration was measured on an etched transverse section.



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Standard Jominy tests were of little benefit because of the shallow hardening characteristics and because the normal experimental error was too great a proportion of the depth of hardness. The L-bar Jominy samples invariably cracked on quenching.

There was a definite correlation between Mn + Si + Cr + Ni and the hardenability as indicated above. Results on heats to which phosphorus was added showed that phosphorus was a potent hardening agent but that its effect in the regular heats was slight since it ranged only from 0.010 to 0.020 per cent.

The spread of analysis and average content of each element for each hardenability depth were determined. Also frequency charts were made showing the content of each element for each hardenability group. There was a general trend of increase in chemical content with increase in hardenability. Good correlations were obtained for silicon and chromium, while the correlations for manganese and nickel were somewhat masked by a shift in the melting range of these elements.

An attempt was made to develop factors for each element to draw the points closer to an average. In spite of elaborate computations, the results were most erratic and it was decided the determination of such factors was unsatisfactory.

Hardenability was plotted versus the ideal critical diameter as computed by Grossman's method. This plot showed about the same spread of points as did the graph for Mn + Si + Cr + Ni versus hardenability. Both curves have two slopes but the break occurs at 0.240 for Grossman's method and 0.190 for the other. It was concluded that the original method of simply adding Mn + Si + Cr + Ni was the most practical.

—G. R. Barrow and G. Soler, *A.S.M. Preprint* No. 13, 1942.

Rolling Seamless Tubes

Condensed from "Transactions," American Society of Mechanical Engineers

The Foren mill for producing seamless tubes is, unlike the various types of plug mills now used for the manufacture of seamless tubes, based on the idea of rolling a pierced billet over a solid bar on the inside, and through a series of successive passes through roll stands, which are so arranged around the solid bar that each pair of rolls covers only a definite angle of the circumference, about 50 deg.

The mill designed and in operation uses 21 roll stands based on a certain contemplated reduction per pass resulting in a considerable elongation of the pierced billet as well as reduction in diameter. The roll speed for each set of rolls must, therefore, correspond to the revolutions for a given tube diameter.

Consequently the motor speed of each set is determined by each different tube diameter and wall thickness. This means that each set must be independently driven.

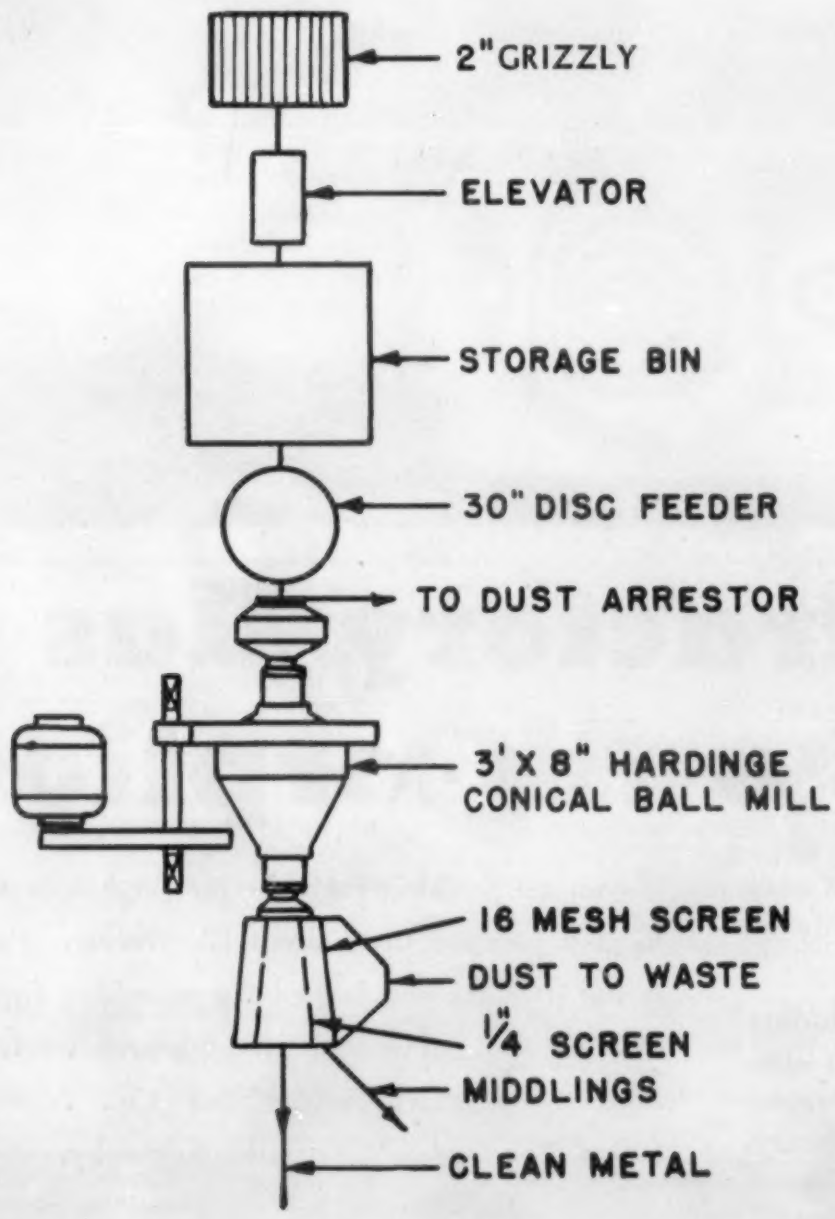
The hollow billet is engaged by the rolls at as many angles as possible, in order to cover the entire circumference. The billet having gone through 4 passes (or 8 sets of rolls) is reduced in diameter as well as in wall thickness and is irregular in cross section. The next (ninth) set of rolls has grooves so designed as to restore its circular cross section.

These 9 rolls constitute 1 rolling cycle and if more rolls are provided every ninth set again restores circular section, and further roll sets are used for freeing the billet from the mandrel bar, and at the same time, of sizing the diameter (the wall thickness having been fixed by the previous passes.)

During the experimental stages it was found that an improvement in the finished product was obtained by increased reductions per roll stand and in increased production (besides a better product) chiefly through conservation of the heat in the pierced billet. The number of roll stands was, therefore, reduced to 13 sets.

The total operating force required on the rolling unit from the billet-heating furnace to delivery on the cooling bed consists of 12 men. In addition, there is 1 man in charge of the lubricating system and 1 for general maintenance. The whole rolling unit is so laid out that all of its operations come within the requirements of straight-line production without any backtracking. A detailed description of layout and performance is given.

—E. W. Wrage, *Trans. Am. Soc. Mech. Engrs.*, Vol. 64, Nov. 1942, pages 745-751.



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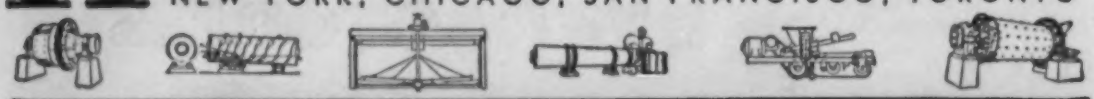

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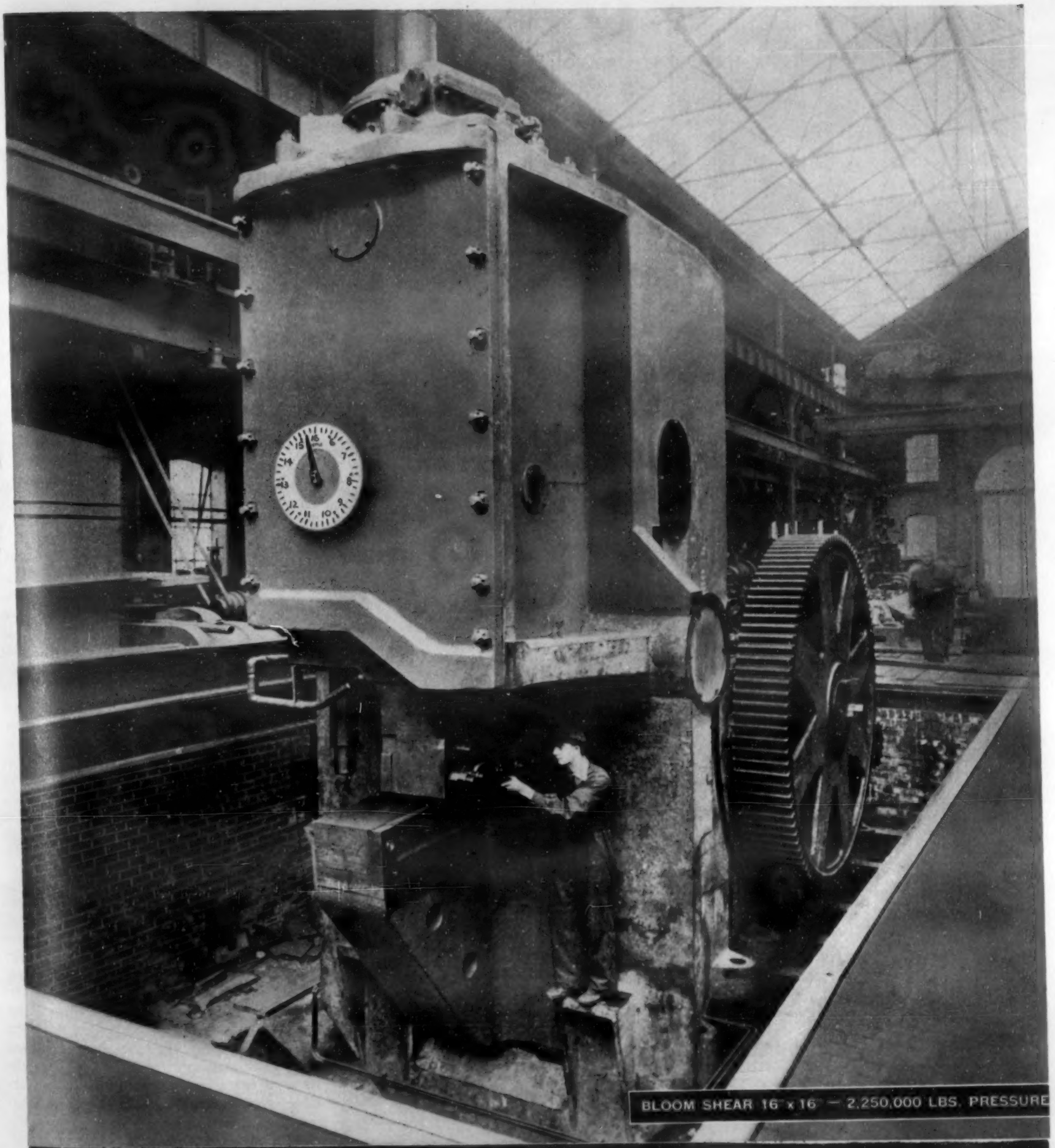

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Non-ferrous Centrifugal Castings

Condensed from "Metal Industry"

Except in cases where centrifugal casting is the only type which will meet the requirements, its main object is to make an article at a lower cost than in a sand mold.

The process requires a rapidly revolving mold and a cover with a hole in it. The hole, through which the metal is poured, must be smaller than the inside diameter of the article or the metal will flush back out.

The first requirement of an article to be cast centrifugally is a straight bore completely through the center. The casting must be made to the smallest bore of the article. If the hole is not central, the entire machine will be out of balance and unless it is unusually heavy, dangerous vibration will result.

Some of the Advantages

The second requirement from the standpoint of cost is that a permanent mold be used and the casting be of such shape that it can be withdrawn. Advantages of centrifugal casting are:

1. Progressive solidification from the outside of the mold, with molten metal always available and under pressure. This makes a casting of 0.6 per cent greater density than that of a perfect sand mold. When the wall thickness of the casting gets too great in relation to the length of the casting, solidification will proceed from two directions at once, resulting in spongy or porous metal around the bore. Pouring the last metal more slowly, or throwing powdered charcoal into the bore as the pour is completed, improves this condition.

2. The cleansing or purifying action in the mold. If the mold is hot enough and the pouring sufficiently fast, both dirt and gas will work through to the bore. A clean bore and turn indicates that the molten metal between is free from defects.

3. The fact that the bore and periphery are concentric. This means that less stock need be allowed on the castings because there is no core which may shift off center.

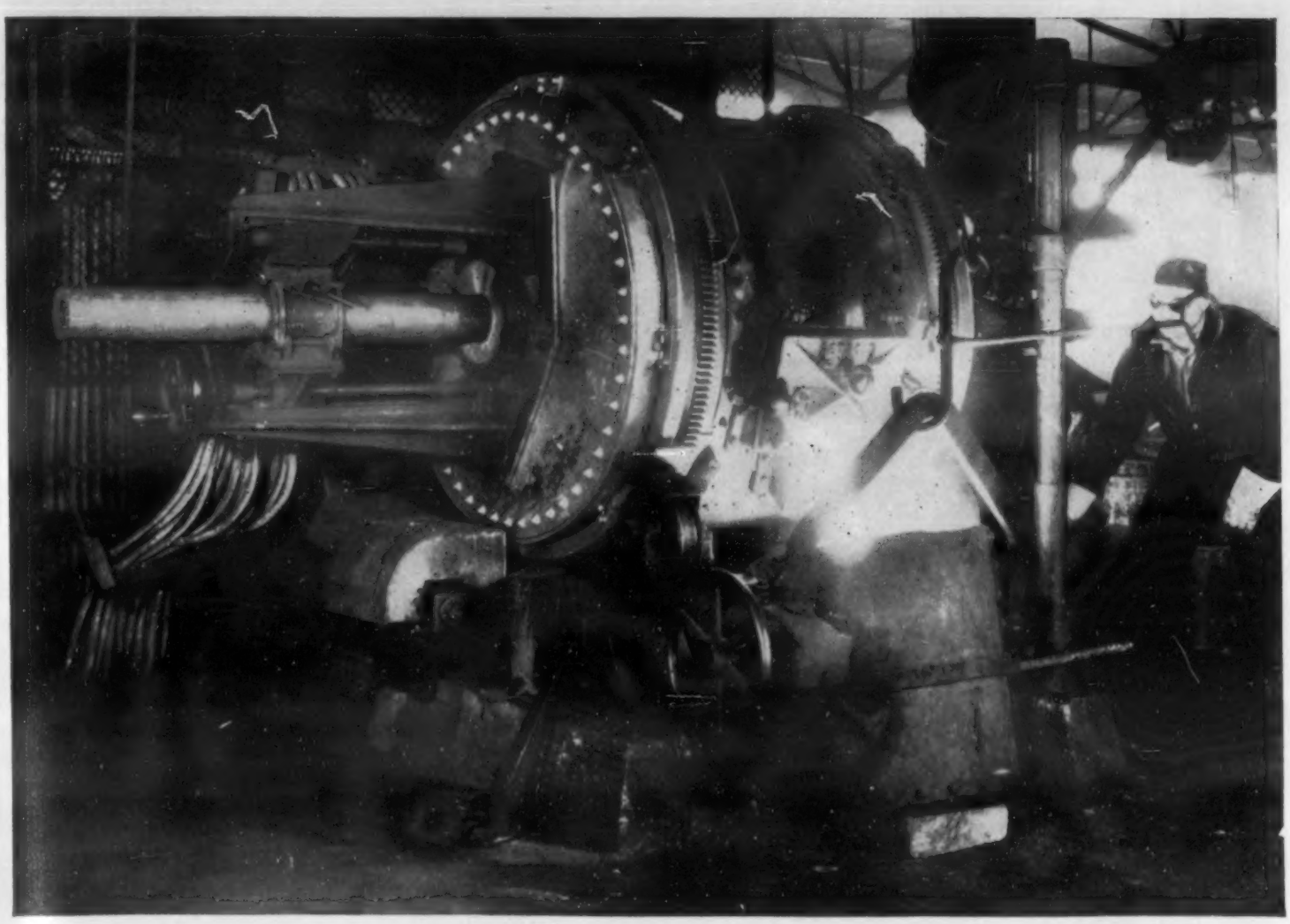
4. Large increase in yield. This is due to the fact that there are no gates, sprues, or risers which saves remelting cost and keeps the foundry free from an accumulation of special mixes. The cleaning room also shows a big saving.

The taper in the bore of a vertically cast piece depends on the relationship of the centrifugal force and the force of gravity. Experience shows that the speed must be increased so that the centrifugal force is about one hundred times the ordinary gravity pull. Speed curves may be plotted for any size bore. These are used only for thin wall castings; with thick walls lower speeds must be used for safety.

The forces on the outside of the flask increase with size, so the design must be strong enough to withstand the contemplated speeds and guards should be installed.

The taper in the bore is also affected by the position of the shaft of the casting machine. A horizontal position will form a perfect cylinder. Tipping toward the

DETROIT ELECTRIC FURNACES



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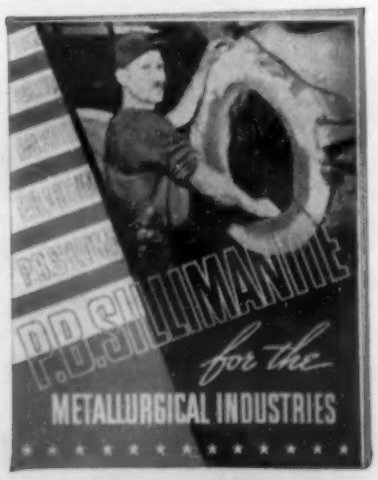

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vertical increases the bore. In the horizontal position it is difficult to introduce the metal fast enough and almost impossible to distribute it correctly over the mold surface. The best angle can be determined only by experience. The metal should be introduced as rapidly as possible, and be directed against the center of the bottom where the rotational movement is least.

When the metal gets up the same speed of rotation as the mold, it will rise with an even rush, carrying the dirt and dross and leaving it in the upper part of the bore and against the cover. As the angle of the shaft is decreased, the dirt and dross spread down the bore. The best operating angle is reached when the bore shows an even distribution of impurities over its entire length.

Facts about Spouts

If the length of the casting exceeds four times the finished bore size, the funnel spout used for the shorter castings must be changed to a bent one, so that the metal will continue to strike the bottom of the mold. When the point is reached where this is no longer possible, the dirt will accumulate at the bottom.

The discharge ends of spouts must be perfectly smooth. A small lip or obstacle deflects part of the stream of metal and causes poor outside finish. Special spouts have been designed for long castings in a horizontal position. In manufacturing centrifugally cast iron pipe, retracting spouts are used. They reach to the far end of the mold and are withdrawn as the metal is deposited.

In making bore diameters of 4 in. and longer, pouring should begin with the machine at rest. This is because pouring cannot be done fast enough to prevent the first layers from chilling, and forming a laminated structure on the surface.

The machine should be started when there is sufficient metal in the mold to cover the surface with a layer thick enough not to chill between revolutions. Too much causes the metal to roll around like a ball, start up and fall back again. This causes oxidation and makes the inside of the casting dirty. Only experience can determine the exact time.

Permanent and Other Molds

Real saving in cost is obtained through the use of permanent molds. The cheapest material for them is graphite purchased in the form of electrodes for electric furnaces. It is easy to machine and can be bored to any shape. Graphite molds are the only ones which can be used with such metals as 80-10-10 or those containing high amounts of phosphorous, as these alloys burn into iron and steel molds.

The metal lies more quietly against graphite. Also, as the graphite has a low coefficient of expansion, the size of the casting does not vary much with changes in temperature of the mold, and the shape does not distort with heat shocks.

One disadvantage of graphite molds is that their softness results in rapid wearing of the walls of the mold. Care in removing castings prolongs the life of the mold. Another is the high heat conductivity of graphite. Blowing powdered bentonite in axially, and letting the centrifugal force distribute it on the side walls, partially offsets both these difficulties. It forms a thin insulating layer and fills in imperfections in the mold. Too much powder will work into the metal and cause lapping.

A draft or taper is used in all permanent molds to facilitate removal of the castings. This can be varied with the length and diameter of the castings.

A semi-permanent mold, made with a pattern, from which two or more castings can be obtained, is desirable when there are not enough pieces to justify a permanent mold. As high as four pieces have been made by using fire clay in place of sand.

Sand is ideal because of its insulating properties. Baked core sand molds make good castings but increased costs result from the difficulty of removing the casting and sand, the time used in slower solidifications and the necessity of cleaning the casting.

The J. I. Case Co., Racine, Wis., has patented a centrifugal casting machine for making cast iron liners for tractor engines. Green sand is used and each mold is formed in the casting machine by a mandrel introduced through the hole in the cover.

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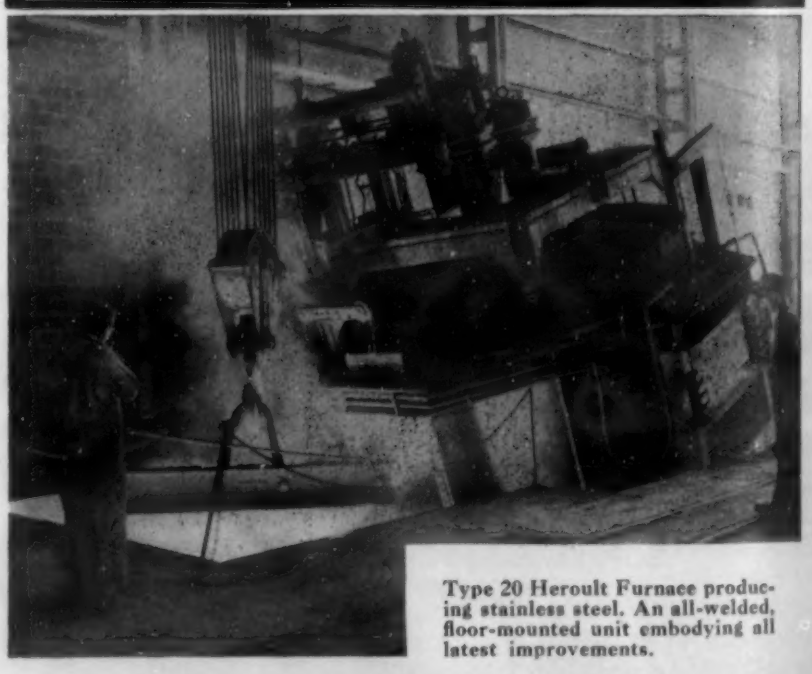

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A great big fan picks me up from the heater chamber . . . shoots me down roomy heat ducts and out into the work chamber through adjustable ports.

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The air velocity is so strong that I'm everywhere at once, hitting every spot in the load with an even blast of heat.

I'm doused in SO_2 - - soaked in it for the duration like every magnesium casting in the load.

None of the stuff seeps out because the Despatch furnace is sealed tight. The whole gang in the foundry are plenty happy over this, too. They've thrown their gas masks away.

And on being discharged with the load I notice the typically efficient Despatch loading system. A new charge goes in, while our load goes off to cool down.

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—Torrid

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Because of loss of heat in pouring, the furnace temperature must be 50 to 80 deg. hotter than for sand-casting. Oxide showing in the bore proves that excessive temperatures are being reached.

A larger heat than the machine can take should not be made up, as holding the metal in the furnace results in metal loss and a varying analysis.

—Harold B. Zuehlke, *Metal Industry*, Vol. 61, Nov. 27, 1942, pages 338-341.

Corebinders

Condensed from "Foundry Trade Journal"

The article includes a survey of materials used: Core-powders, rosin and pitch, oils, paste binders, and core creams. It is suggested that economy can be achieved by substituting natural bonded sand for oil sand, by using lower proportions of corebinder than in normal practice, by more extensive use of permanent or semi-permanent cores.

Three Groups of Materials

The individual materials in general use can be classified broadly into 3 groups: solids, viscous liquids, and oils of various types. The principal solid binders include various types of dextrine and soluble starch. Dextrine as a binder is very susceptible to small changes in moisture content of the sand. A different class of soluble starch, better known as a core-powder, has come into prominence during the last 5 to 7 yrs.

Neither dextrine nor starch imparts true moisture resistance to the dried core. In general practice something like 2 per cent by weight of dextrine or starch is usual, while the addition to this mixture of 0.5 per cent by weight of linseed oil will give excellent dry strength, using a clean silica sand. Rosin and pitch are very similar in their characteristics as corebinders. They impart only slight green strength with fair dry strength but have excellent moisture resisting properties. Lime-treated rosin in finely powdered form, which does not adhere to form a solid mass on standing, is used in America for direct mixing in sand, and is now also available in England. The most commonly used American type of wood resin is produced from shavings and pin roots by distillation.

Sulphite Lye As A Binder

Powdered wood extract (sulphite lye), as well as the concentrated liquid form, is available for use as a corebinder. The concentrated "lye" is used mainly for the improvement of molding sands, and contains from 6 to 17 per cent mineral ash. Its low baking temperature and cheapness are obvious reasons for its extended use as a corebinder.

The paste or semi-solid class of core compound consists principally of emulsified mixtures of dextrine, oil and water, sometimes with the addition of molasses or glucose.

The cream type of binder is an intermediate stage between pastes and thin oils. They consist of emulsions of oil, water and dextrine, flour, molasses or bentonite in varying proportions. The creams mix more readily with sand than the paste binders, and in general give higher dry strength with lower green strength.

Naturally bonded sand, baking practice, use of recovered core sand, dry-strength and gas content, storage of dried cores, etc. are also discussed.

—A. Tipper, *Foundry Trade J.*, Vol. 68, Sept. 10, 1942, pages 27-31; Sept. 24, 1942, pages 71-76.

Strength vs. Composition of Cast Iron

Condensed from "Die Giesserei"

In ordinary cast iron the most important constituents in their effect on properties are carbon and silicon. For many years the sum of carbon + silicon has been studied as the basis for a criterion of the mechanical properties of cast iron, but with generally fruitless results.

Although the line of demarcation between white and gray solidification seems to depend on carbon and silicon, discrepancies arise through differences in melting practice and other factors. Osann's rule that the 2 parts of silicon can replace part of carbon works in some cases, but in others leads to absurdities, since equal strengths are postulated for eutectic and pearlitic structures containing the same sum of carbon + ½ silicon.

A potentially highly useful (and strangely neglected) formula is that developed by Heyn in 1910 and later corrected by Hanemann and Schrader. This states that the "degree of saturation" (S_e)-% carbon/(4.25 — %Si/3.2). Diagrammatic and tabular analysis of this shows that 0.1 per cent Si changes the tensile strength by 2.25 per cent, and 0.1 per cent C by 8.67 per cent.

Thus it follows that as far as influence on tensile strength is concerned, one part of carbon is equivalent to 3.8 parts of silicon. However the method of calculating the saturation is somewhat complicated.

Piwowarsky has developed and used a simple formula, C + ⅓ Si, as a guide to the strength-equivalents of carbon and silicon. In order to find the relationship between Piwowarsky's C + ⅓ Si and the S_e value described above, the author has calculated all these values and their relationships for common cast irons having silicon contents of 0.6 to 3.4 per cent, and carbon contents of 2.6 to 3.6 per cent, and shows that the discrepancies are very low.

From the discrepancies and practical observations the author has sought an even better rule than Piwowarsky's, and now suggests the sum of carbon + 0.3 silicon as a refinement of the earlier formula. A slight additional advantage for the author's rule is that it is easier to multiply by 0.3 than to divide by 3, particularly in one's head.

Actually, both C + ½ Si and C + 0.3 Si fulfill the practical requirements more conveniently than does the S_e value. As far as their influence on tensile strength

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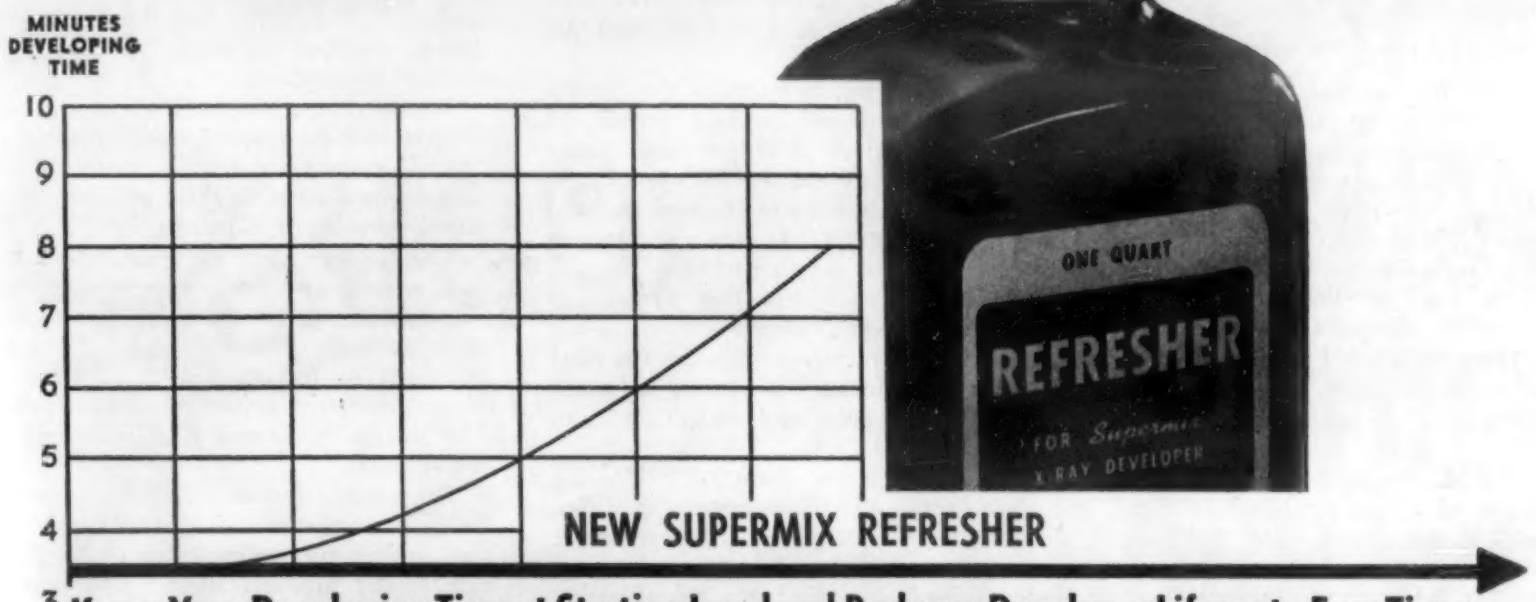

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is concerned, 3 parts of silicon are roughly equivalent to 1 part of carbon.

For those who favor the saturation value method, the author has also developed an easy-to-remember formula that gives results almost identical (max. discrepancy — 2.2 per cent) with the usual S_e formula. The "simplified" version is $S_e = [(C + \frac{1}{4} Si)4] - 0.04$.

—August Gimmy, *Giesserei*, Vol. 29, June 26, 1942, pages 226-230 (abstracted in *Engineers' Digest*, Vol. 3, Oct. 1942, pages 343-346.)

Sound 85-5-5-5 Castings

Condensed from "Metallurgia"

One of the most useful alloys for general non-ferrous casting purposes is a copper alloy composed of approximately 85 per cent Cu and 5 per cent each of tin, zinc and lead, known as 85-5-5-5. Having a reasonable degree of strength and satisfactory corrosion-resisting properties, it is widely used in the production of pressure castings, frequently for bearings, and less often in general engineering applications at temperatures under 230 deg. C. (446 deg. F.) It has a relatively low cost.

The A.S.T.M. designation B. 62-41 is representative of alloys produced in England as well as the United States and Canada. The minimum tensile strength specified is 30,000 lbs. per sq. in. but good foundry practice usually provides an average of 33,000 lbs. per sq. in. Within the range of composition allowed, there may be a wide range of tensile properties, depending upon the relative proportions of zinc and tin present.

When properly cast, 85-5-5-5 should be sound and free from internal porosity. An examination of rejected castings was made and a comparison of "good" and "bad" ones shows the influence of each element present on the casting properties.

Effect of Tin

In both cases deficiency of tin was found. In "good" casting it was greater, the per cent shown being 3.10 in the "good" and 3.80 in the "bad." The minimum specification is 4.00 with 5.00 per cent desired.

Phosphorus, which increases the fluidity of the metal, should be kept within the specified maximum, 0.05 per cent. Any increase lengthens the solidification range, increasing the tendency to unsoundness, and hardening the metal. It may also promote the formation of rough surfaces.

Up to 1.00 per cent the presence of nickel is beneficial. Larger amounts break up the cored structure and render the alloy sluggish in pouring. They also raise the initial freezing point and change the color of the material.

Aluminum, in the form of oxide, has a detrimental effect on casting qualities. In solution its harmful qualities are more difficult to establish. It may render castings unsound as it affects the crystallization characteristics and it is believed to be the major cause of tin sweat.

Sulphur does not appear to affect the casting qualities or physical properties provided there is no tendency to promote the formation of sulphide inclusions.

Silicon is Harmful

Silicon appears to be harmful even when present in small proportions due to the more ready formation of dross by the interaction between compounds of lead and silicon. In the "bad" material silicon probably exists in an insoluble form such as an oxide, very non-uniformly distributed.

Macrosections of "good" and "bad" castings show finer structure in the former and there is evidence that the larger grain size in the "bad" is partly due to a higher casting temperature.

Microsections, prepared where cracks or defects had been noted, show that in the "good" casting the lead is uniformly distributed and there is little evidence of internal porosity or blowholes.

The microstructure of a discolored fracture, usually associated with poor castings, shows lead segregation. This is associated with porosity, probably caused by either shrinkage or gassing during solidification. It also contains copper oxide and silica. The section is porous with numerous internal cracks.

The remedy for such fractures seems to lie in a more complete deoxidation of the melt and in the prevention of lead segregation locally in the casting. Strict control of casting temperature is necessary.

—William F. Chubb, *Metallurgia*, Vol. 26, Nov. 1942, pages 7-9.

Aircraft Castings

Condensed from "Foundry Trade Journal"

Various materials are used in connection with the manufacture of the pattern and dies. Cast iron is frequently resorted to for coreboxes. Other materials reported to be in common use were plaster of Paris, stone, a lead-tin alloy, and dental wax. Gating and venting systems, reproduction from master patterns, chills and core carriers, foundry control laboratory etc. are discussed.

The author's laboratory is equipped with two X-ray units. The larger of the two units — a 200 K.V. set — is used for all classes of materials, including aluminum, aluminum alloys, aluminum bronze, phosphor bronze, silicon bronze, and certain thicknesses of steel and cast iron. They regard this method of examination of castings, with the consequent elimination of trouble at a later stage in the machine shops, as a sound economic proposition.

Use of the Spectrograph

Spectrographic analysis is firmly established. A great number of samples are analyzed for magnesium, with the apparatus, in addition to a full analysis of a percentage of the samples. Further developments are under way on the use of the spectrograph in connection with the foundry problem, and the conservation of light alloys which will more than justify the foresight of the company in adopting this method of analysis.

An August-Simpson miniature sand mixer, which is an exact replica of the 5-ton per hr. mixers, serves to give the laboratory samples of mixed sand on which to carry out tests. Pressure testing by

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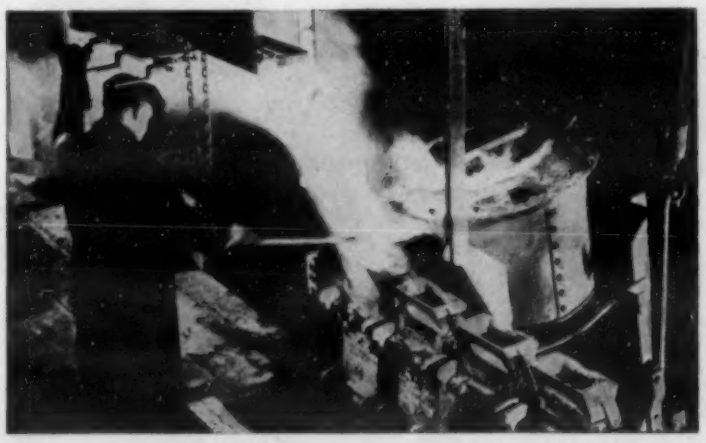

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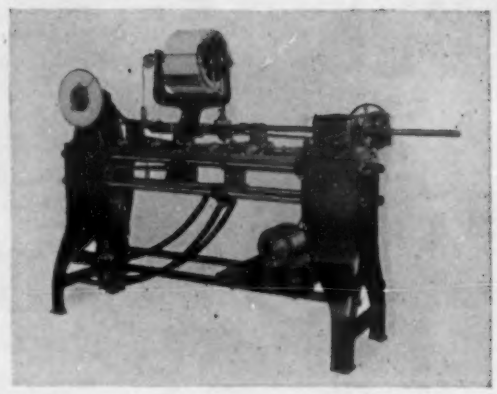

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means of immersing the casting in hot water and applying air pressure inside the area to be tested is frequently used, and affords a rapid check against porous areas.

Experience has shown that the reject hazards due to porosity and cracking are highest in die-castings, and for this reason all die-castings are passed through a most searching inspection by chalk testing immediately after the runners and risers have been sawn off, but before any other fettling operations are carried out.

Testing for Porosity

The casting to be tested is first of all soaked in a tank of hot penetrating oil, and afterwards covered with French chalk. The oil having first penetrated into any crack or flow in the casting, then oozes back into the chalk, leaving a very clear indication of the presence of a fault.

Coremaking, coredressing, molding, sand preparations, melting practice heat treatment, aluminum die-castings etc., are also discussed and illustrated with a number of photographs. Rolls-Royce have adopted a policy of producing as many aluminum castings as possible as die-castings. Some of the castings produced involve the use of sand cores to form internal passages, although the foundry die designers endeavor to modify designs to eliminate the use of sand or multi-piece cores as far as possible. The metal is poured into the die at a temperature of 710 to 720 deg. C. (1310 to 1328 deg. F.)

—*Foundry Trade J.*, Vol. 68, 1942, Sept. 3, pages 3-8; Sept. 17, pages 49-54; Oct. 1, pages 89-94; Oct. 15, pages 141-144; Oct. 29, pages 187-190.

Saving Fuel

Condensed from "Foundry Trade Journal"

This is a paper read before the London Branch of the Institute of British Foundrymen on Oct. 24. Rowe (F. W. Rowe "Modern Problems and Developments in Engineering Bronze Founding," *Proc.* Inst. Brit. Foundrymen, 1924-25, Vol. 18 p. 456) has published the data and Cassidy and Logan (C. L. Cassidy, "Non-Ferrous Castings" *Foundry Tr. J.* 1936, p. 231 and "Crucible Furnaces" *Foundry Tr. J.* 1932, p. 319, by A. Logan) have also commentated upon the fuel requirements of furnaces used in the brass foundry. Logan points out that in the case of the natural-draft pit fire, the coke to metal ratio is poor.

Taking an overall efficiency the fuel required to melt a ton of gunmetal would be ½ ton. With the forced-draft type of furnace the fuel ratio is 1:4½ and even in some cases 1:5.

In the oil-fired crucible furnace, it takes approximately 28 gals. of oil to raise a ton of gunmetal to the correct pouring temperature. In the case of non-crucible furnaces the oil consumption is less, and can be taken as 22 gals. per ton of gunmetal melted.

In the more common brass-foundry melting operations, particularly as regards coke, it is essential to have plenty of air available for combustion.

Since the cupola is still the most commonly used melting unit for the production of gray iron castings and accounts for over 90 per cent of all iron castings produced, it is very important that attention should be given to fuel conservation in this type of furnace. Unlike most furnaces the weight of coke in the cupola bed does not give a correct idea of its efficiency. The height of the bed above the tuyeres is the important factor. Hard cupola coke usually has a density of 25 to 30 lbs. per cu. ft.

The actual height of the coke bed in any cupola will depend on the type of metal being melted. For ordinary phosphoric cast iron without steel scrap in the charge, it will vary between 24 and 30 in. above the center line of the tuyeres, but for high steel scrap charges and high duty cast irons in general, it must be increased to 36 or 48 in., particularly where it is essential that the first metal to be tapped shall be at a high temperature.

Electric power consumed for lighting purposes is a large item in these days. It might be possible to save some electric power if occasional attention were given to the fitting or cleaning of reflectors. Very few foundries pay attention to this point, and allow lamps and reflectors to become covered with dust and grime so that a 500-watt bulb gives the light of a 400-watt.

—Frank Hudson and A. E. McRae Smith, *Foundry Trade J.*, Vol. 68, Nov. 5, 1942, pages 209-214.

One crucible furnace or a dozen represents a small investment when you consider the rate of production made possible through the use of crucibles for melting non-ferrous alloys. Gas, oil or coke may be used as fuel. The crucibles are lifted out with tongs, and without transferring the metal to any other container, the flasks are poured off *direct*. The metal can't chill. Time required for melting is about half an hour.

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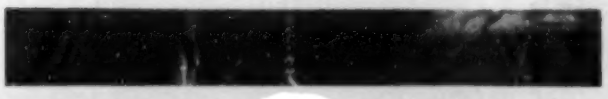

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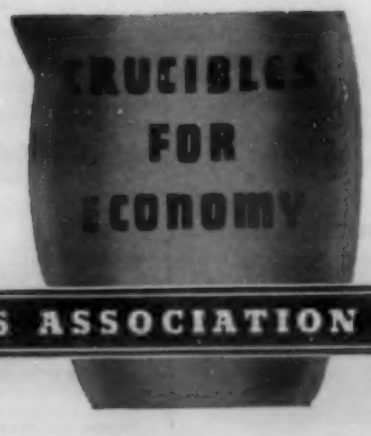

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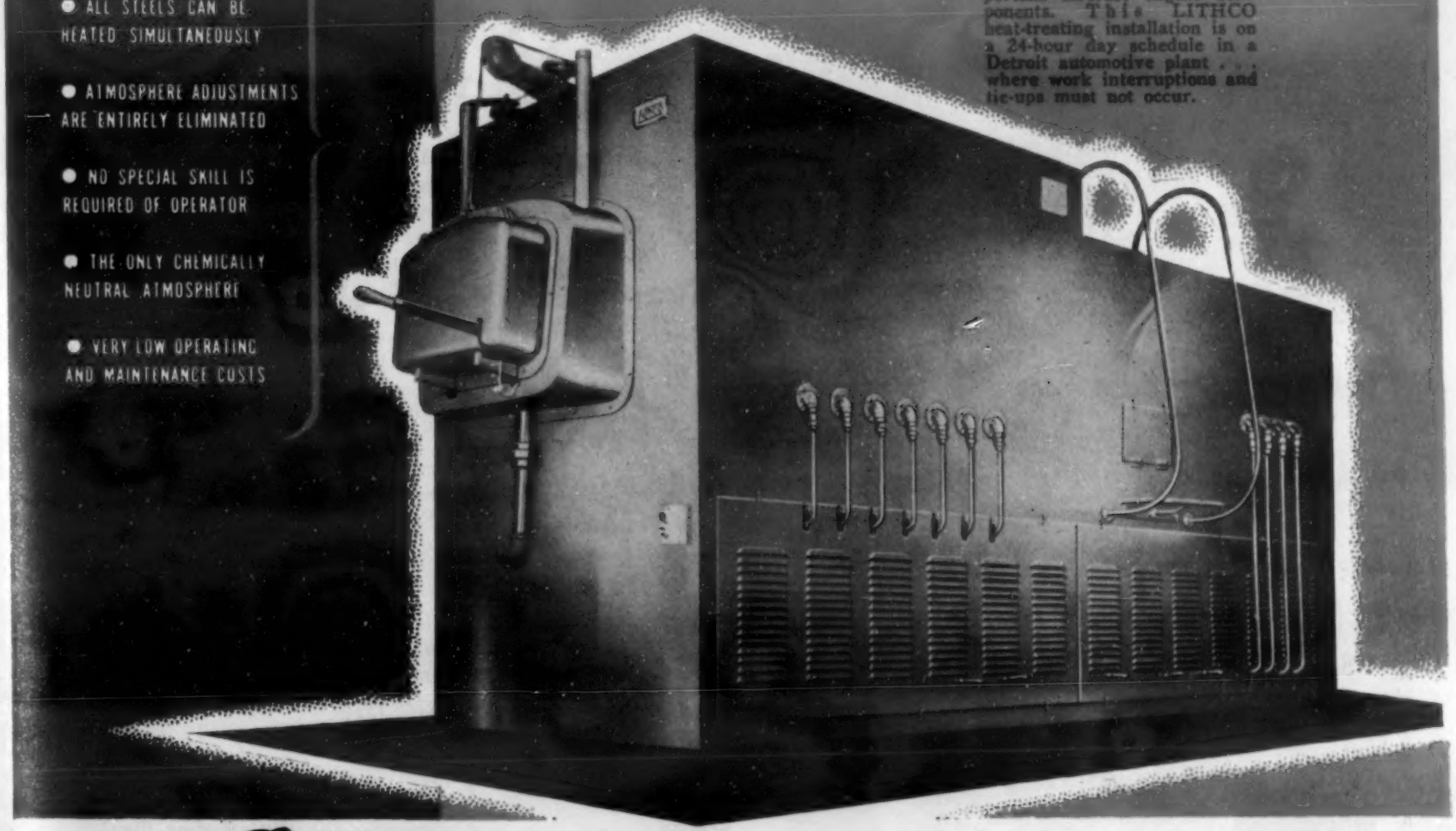

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Heat Treating H.E. Shells

Condensed from "Metal Progress"

Conservation of manganese and need for greater shell strength has caused the replacement of X-1340 steels, which are satisfactory in the air-cooled condition, for medium caliber shells, by heat treated steels containing about two-thirds the manganese. This has enabled the specification for strength and ductility to be improved.

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The Hardening Furnace

The heat treat is completely automatic. The table consists of parallel extensions of the furnace tubes. Tops of these tubes are cut off, and the shells being charged are placed ahead of the pusher lug at the beginning of its stroke. The fresh shells pushed into the hardening furnace tubes shove the extra line ahead. As the pusher returns new shells are loaded. A standard hydraulic cylinder, either air or oil operated, controlled by solenoid valves, is used for power.

In the hardening furnace the tubes are designed to maintain proper alignment of the shells and insure uniform heating. Each size of shell requires its own size of tube. They are made in sections, the leading end anchored, the other with a slip joint, and slotted to provide circulation of furnace gases. Individual rollers support each section. Tubes, rollers and supporting shoes are of 12-27 Cr-Ni heat-resisting alloy.

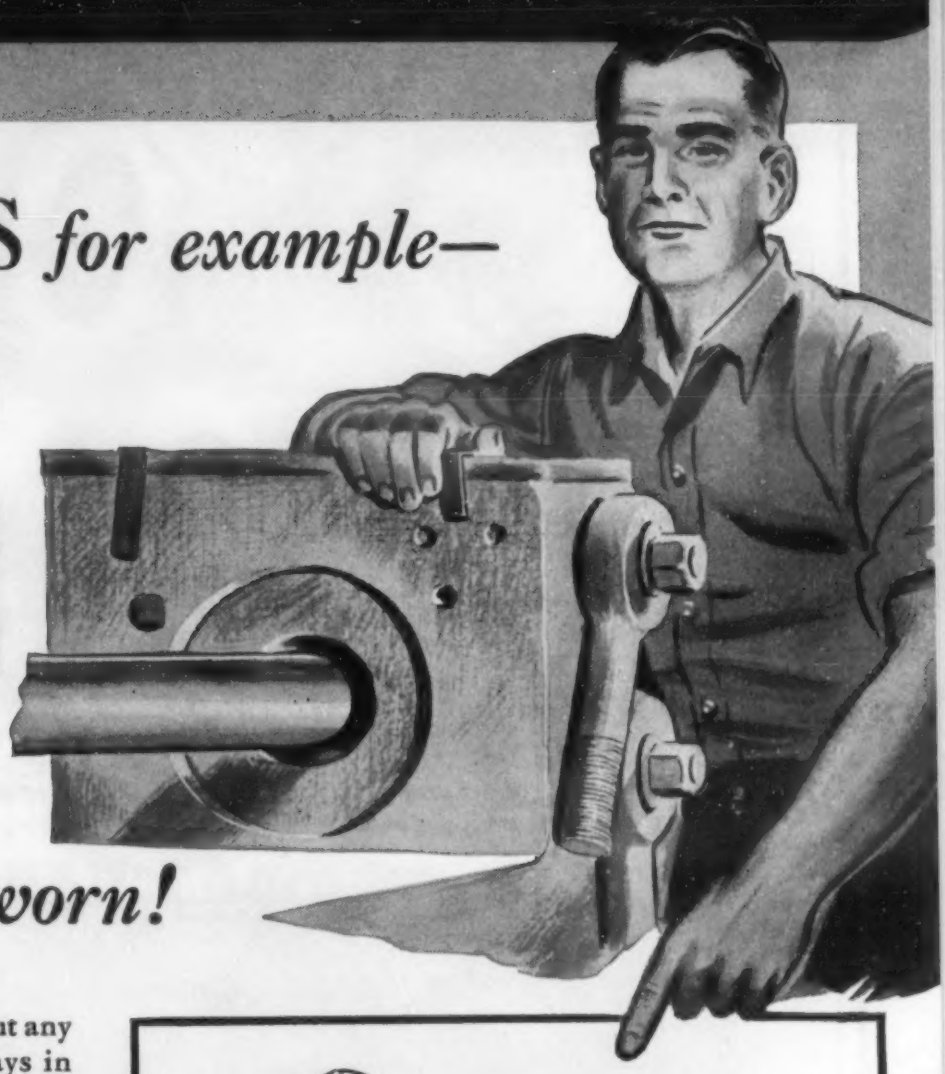
In shell designs where the nose opening of the shell is not small enough to prevent slipping over the lug of the shell ahead, a small breaker bar automatically separates the shells before they drop into the quenching fixture.

The furnace may be fired with gas or oil fuel. The burners are placed along the sides of the furnace, overfiring the heating zone along the arch of the furnace, the gases passing down the opposite side, under the tubes through flues at floor levels.

This constant circulation, with the radiant effects of the hot arch and furnace walls, assures the necessary uniform, thorough and rapid heating of the tubes. It is further assured by the high conductivity and diffusing action of the tubes.

In the case of gas, standard tunnel type burners are used; with oil fuels, double atomizing oil burners. The furnace is divided into three zones. The first, about 10 to 15 per cent of heating capacity, is manually controlled. The second, for bringing the shell up to quenching temperature, 40 to 50 per cent of capacity, is controlled with indicating and controlling pyrometers operating the valve motors and proportioning valves. The final or soaking zone is similarly controlled by recording and controlling pyrometers. Subjecting the cold steel to slow initial heat avoids thermal shock.

IS CHROMIUM PLATING YOUR ANSWER TO EXTENDING THE LIFE OF VALUABLE TOOLS AND EQUIPMENT?



MACHINE TOOLS *for example—*

CHROMIUM PLATING

may increase output of your cutting and forming tools . . .

reclaim them when worn!

OBTAINING GREATER PRODUCTION per tool without any sacrifice in accuracy . . . meeting quotas despite delays in obtaining new tools and tool steels. These are two problems that chromium plating may be able to solve for you.

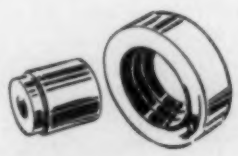
By applying a chromium plated surface to many types of cutting and forming tools, greatly increased service life is obtained. In addition, when worn undersize, they can be put back into production again simply by stripping, re-plating and grinding to size.

For example, chromium plated mandrels and dies last many times longer, reduce stoppages and speed output. Chromium plated taps—working in copper, brass, aluminum, nickel, rubber and plastics—often give 3 to 10 times increased production. On broaches and burnishing bars, chromium plating eliminates seizing, produces a finer finish and steps up service life.

FOR MANY OTHER EQUIPMENT PARTS

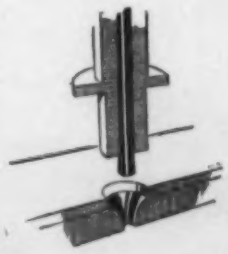
This is just one of countless ways that chromium plating saves valuable materials and man-hours for war production . . . by extending the life of a wide variety of surfaces subject to wear and corrosion . . . by reclaiming many hard-to-replace equipment and production parts which have been worn or machined off-size and would otherwise have to be scrapped. Successful applications of chromium plating for both new equipment and salvage include:—plug and ring gauges, ball and roller bearing parts, piston rods, drive shafts, axles, cylinders, shafts, and many types of spindles, fixtures and jigs.

THE BOOKLET SHOWN *will assist you in determining the applications for chromium plating on your products and equipment. A copy of "The Last Thousandth of An Inch That Speeds Production" is yours for the asking. In writing, please mention* Metals & Alloys.

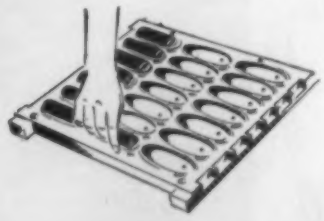


TEN TIMES LONGER LIFE FROM DIES AND MANDRELS

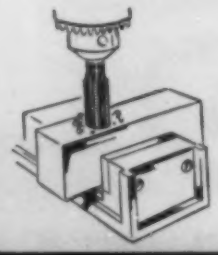
SMOOTHER, FASTER WORK FROM BROACHES AND BURNISHING BARS



WEAR AND ABRASION REDUCED ON FORMING TOOLS



MOLDING DIE LIFE GREATLY INCREASED



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be sure you get these features

Check List

Shell—Reinforced steel, non-warping

Lining—Preburned shapes, tongued and grooved

Arch—Preburned shapes, lap joints

Hearth—SiC, nonwarping, high heat conductor 70% supported, non-electrical conductor

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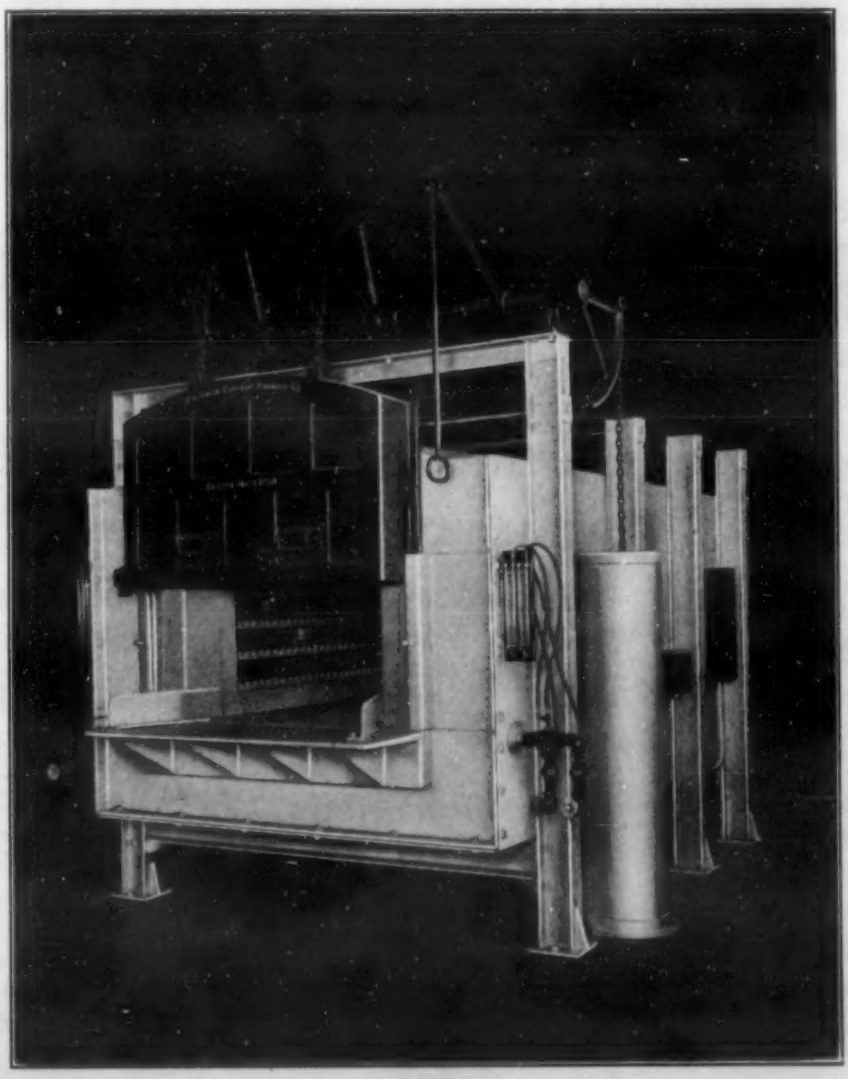
Door—C.I. insulated, self-aligning, lock seal

Heating Elements—NiCr, low density, long life

Atmosphere Control—Gases forced through narrow slot filling work chamber and enveloping work with desired atmosphere.



The Model B3684 Box Furnace Work Chamber 36" w x 84" l x 22" h. . Capacity 850 lbs. per hour. To 1500°F.

American Electric Furnace Company

29 Von Hillern St. Boston, Mass, U.S.A.

Industrial Furnaces for All Purposes

The furnace has a 9-in. firebrick lining, backed with 4½ in. of 1600 deg. insulating brick. Its shell is built of welded plate, reinforced with steel structural shapes and cast iron fronts. The cast iron door at the discharge end is lined with insulating refractories. Air for combustion is supplied at 1 lb. pressure by turbo-blowers. To hold scaling and decarburization to a minimum, gas-air proportioning valves normally maintain the atmosphere slightly on the reducing side.

The Quench Tank

Shells are discharged by alloy tubular chutes through the furnace floor into individual quench cages. The tubes are water jacketed between furnace bottom and oil level. Internal jet tubes in the cages constantly pump oil at a pressure of 30 to 35 lbs. per sq. in., giving a through internal flush. Before this, oil at the same temperature and pressure, entering the discharge tube, just below the water jacketed section, gives an external spray.

The cages rotate 180 deg. and the six shells drop onto six parallel pusher conveyors which send them through the tank to the draw furnace's conveyor. Coming out butt first allows the oil to drain. The turnover mechanism is operated hydraulically by an oil cylinder, chain and sprocket. The conveyor is driven by a standard motor, operating through a speed reducer and variable speed pulley. About one gallon of tank capacity is allowed per pound of steel quenched per hour, with six changes of oil.

A separate cooling unit maintains correct oil temperature. It receives hot oil from the tank, cools and recirculates it. The tank is built of heavy welded steel plate with structural steel reinforcement and conveyor frame, placed in a pit with its top at floor level. A conveyor belt carries the shells to the recirculating air draw furnace.

The Air Draw Furnace

The heating cycle of the draw furnace can be controlled independently since the conveyor belt is driven by a separate motor. Two fan systems, with individual combustion chambers, provide better than 50 changes of hot air every minute. Fan impellers and housings are of heat-resisting alloys; the impellers are on special air cooled shafts and bearings, powered by standard motors with V-belt drives.

Hot air enters the top of the furnace arch, circulates downward, and returns through ducts in the bottom to side manifolds. Dampers, beneath the inlets and in the return ducts, control it. Heat, added from hot gases discharged from the combustion chambers into the recirculating system at the fan discharge, maintains correct temperature. Either oil or gas fuel is used. Air is supplied at 1 lb. pressure by turbo-blowers for proper pressure in the combustion chamber.

Safety equipment consists of standard air flow switches and fuel safety shut-off valves, and flame guards for gas operation. The furnace has a standard, heavy duty, welded plate shell reinforced with structural steel shapes, lined with 4½ in. fire brick backed with 2½ in. of 1600 deg. brick and 1 in. of insulating blocks.

A SPECIAL EGYPTIAN CLEAR LACQUER to Apply Over Black Oxide Coatings

Experience-taught formulators in EGYPTIAN laboratories have developed this special lacquer to provide needed protection against salt spray and staining in handling Black Oxide Coated articles.

Many war contracts require such protection.

Oil, sometimes used for this purpose, is at best a temporary expedient. It has no advantages beyond immediate protection. Articles so coated are unpleasant and hard to handle.

EGYPTIAN Special Clear Lacquer used over Black Oxide Coated articles, is meeting with unqualified success on all fronts. It provides full protection against staining and spotting from handling, and also against that destructive ally of corrosion—salt spray.

Let us send you a sample of this new EGYPTIAN finish, and information about other EGYPTIAN items that are triumphing over the harsh uses and frequent abuses of war service.

Have you a copy of our loose-leaf booklet, "U. S. Government Specification Finishes," indispensable to war plants with metal finishing problems? Just ask for "Spec" Book MA.

These are a few of the more important Government "Spec." finishes which we can furnish. For more complete list send for "Spec." book.

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TYPE I and II
LUSTRELESS PAINT FOR AMMUNITION

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NITROCELLULOSE LACQUER ENAMEL
FOR AMMUNITION

P-27-b-2
ZINC CHROMATE PRIMER

84
ZINC CHROMATE PRIMER

AN-TT-P-656
ZINC CHROMATE PRIMER

PXS-979
LACQUER ENAMEL FOR AMMUNITION
(CELLULOSE TYPE)

EGYPTIAN FINISHES

THE EGYPTIAN LACQUER MANUFACTURING CO.
ROCKEFELLER CENTER, NEW YORK, N. Y.

EGYPTIAN *Superior* FINISHES

Plain Talk on the Nickel Alloy Situation and Your Requirements

The acuteness of the nickel shortage is a matter of public knowledge since even the nickel content has been taken out of our familiar five cent pieces.

Both you and we have known for some time that nickel must be used sparingly. At the same time, all metals used in the war effort must be conserved. We therefore recommend the use of nickel in moderate amounts, where it will save the use of greater quantities of other metals which are also in the critical class.

In heat treating operations, equipment and parts of Amsco Alloy, which contains the proper amount of nickel, stand up for much longer periods than those which may have contained nickel in smaller amounts. The nickel content of Amsco Alloy justifies itself by reducing to a minimum costly shutdowns and time-out-for-repairs in heat treating departments. Less frequent replacements mean conservation of metal and of the labor required to produce parts and equipment.

While it has been found entirely practicable on heat treating equipment parts and containers to make metal sections of Amsco Alloy substantially thinner than those of ordinary metals, conservation by longer life predominates in Amsco designs. Appreciable quantities of critical metals have been conserved through the recommendations of Amsco engineers.

Amsco Nickel-Chromium Alloy containers are used for annealing and carburizing, normalizing, stress relieving, spheroidizing, cyaniding, nitriding, salt bath and pack hardening — applications where resistance to high temperature and corrosion is imperative. Amsco Alloy in the prescribed grade excels for containers for each of these processes, because it assures operating economies, greater service as a result of freedom from abnormal breakage, cracking, warping and distortion; and the maintenance of strength and creep resistance at high temperatures.

Write for Bulletin 1041-A.

R-139 Muffle for heat-treating of small parts.
R-356 A pot of F-1 Amsco Alloy for heat treating gears at about 1800° F. in molten salts.
R-256 F-1 pot for case-hardening automobile parts in cyanide; an application requiring resistance to both heat and corrosion.

Better steel requires more scrap!

Amsco
AMERICAN MANGANESE STEEL DIVISION
Chicago Heights, Illinois

THE AMERICAN Brake Shoe AND FOUNDRY COMPANY

FOUNDRIES AT CHICAGO HEIGHTS, ILL.; NEW CASTLE, DEL.; DENVER, COLO.; OAKLAND, CALIF.; LOS ANGELES, CALIF.; ST LOUIS, MO.
OFFICES IN PRINCIPAL CITIES

The Cooling Chamber

Here the shells are brought down slowly to a temperature (150 to 175 deg. F.) at which they can be handled. Handling is done by a heavy conveyor belt surrounded by a water jacket, with a large fan at the entrance end to draw cold air from the discharge end. Controllable water sprays complete the cooling. Shells are then checked for hardness and ready for final machining.

Much work has been done to determine the proper heat-treating temperatures and cycles for different shells. Allowance has to be made for different wall thickness in each size. This is best determined by preliminary tests on the different lots of steel.

Temperature and time must be sufficiently high and long to ensure complete solution of the carbides and to recrystallize the austenitic grain. High forging heat produces a coarse grain structure. On such forgings a higher hardening temperature than usual is necessary.

Experience shows that the automatic 4-cycle installation (harden, quench, draw and cool) refines the grain structure when due allowance is made in time and temperature for the microstructure, grain size and composition of the original forgings.

—D. H. Gardner and John Wallerius, *Metal Progress*, Vol. 42, Nov. 1942, pp. 861-866

Forging Aluminum Alloys

Condensed from "Heat Treating and Forging"

Forging of aluminum and its alloys is a relatively new industry. Three years ago only about 1.5 per cent of the aluminum produced by the United States went into forgings. At present forgings consume about 12 per cent of the nation's aluminum production and the proportion will continue to increase.

Forging Stock

In preparing forging stock, care should be taken to preserve the most advantageous grain flow in the proper direction in order to present maximum strength at the points where the forging will bear the greatest strain in actual use. Stock should first be cut into billets of the size that has been determined as most economical for the production of the particular job.

Stock not more than 2¾ in. thick may be sheared in a 250-ton shear. If the finish of the cut edge is unimportant, a band-saw may be used. Where a smooth finish is desired, however, cutting by an abrasive wheel is recommended.

In some cases, particularly where the forging is to be of large size, the billet is made from a whole ingot and worked into a preliminary wrought structure by a hydraulic press. Flat dies used in the press should have a corner radii of 4 in. to prevent tearing or cutting. Pressures range from 1500 to 3000 tons.

Forging Dies

It is important that dies have correct draft, shrinkage, and mismatch tolerances. When final shape of forging does not provide a natural draft, a 7-deg. draft should usually be provided. A draft angle of 0.25 deg. is generally ample for press forgings.

"TYGON PAINT RESISTS 90% OF THE KNOWN CORROSIVES"

Excerpt from a Research Report to U.S. Stoneware's Committee on Corrosion Control, January 3, 1943:

". . . replies to our survey among users of Tygon have proven extremely helpful in broadening our knowledge of Tygon's chemical resistance under difficult operating conditions. Incidentally, you will be interested to learn that the surveys indicate Tygon Paint withstands the attack of more than 90% of the known corrosives."

—D. F. Siddall, Director of Research.

Tygon Paint possesses the basic corrosion-resistant characteristics of the parent Tygon — the amazing synthetic, rubber-like material, used in the manufacture and handling of innumerable corrosive agents. Tygon Paint is pure Tygon, liquefied by the addition of solvents, which on evaporation leave a sturdy, durable film of chemically unchanged Tygon.

Tygon Paint is used to protect wood, metal or concrete from the attack of corrosive fumes, condensates, occasional spillage, or from exposure to moisture, oils, sunlight, air, or other oxidizing elements. Tygon Paint shows no tendency to crack, craze, check, or "weather," even after long exposure. Tygon is unaffected by water, fresh or salt (continuous exposure for more than 1000 hours in salt spray tests showed no effect). Tygon Paint possesses high dielectric strength, of importance where electrolysis is present.

Tygon Paint films are flexible. They neither become brittle at temperatures well below zero, nor soften at temperatures as high as 150 degrees F.

Tygon Paint may be applied by spray, brush, dipping or roller-coating to wood, concrete or metal surfaces. May be air-dried or baked. Formulations include black, white, clear, and a wide range of colors.

For detailed information on the use of Tygon Paint, and other Tygon corrosion-resistant materials: linings, rigid or flexible tubing, gasketing impregnating solutions, or molded Tygon products — write Engineering Department, The U.S. Stoneware Company, Akron, Ohio. In Canada: Chamberlain Engineering, Ltd., Montreal.

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Whether you need a small or large furnace, R-S Engineers can design an installation to meet the exact requirements encountered in your own plant.

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For upset forgings, a draft angle of about 1 deg. is sufficient.

The principal parts of a die for small hammer work are a fuller, edger, bender, blocker, and impression. Metal is roughly drawn out and shaped on the fuller and edger. Bending is next, if required. Metal should be of such shape as to fill the blocker completely by the time it reaches that point. Forging is brought to exact size and shape in the impression die, which has well defined corners and radii. Some forgings do not require all these steps.

Steel most frequently used for forging dies contains 1 to 1.5 Ni, 0.50 to 0.80 Cr, 0.25 to 0.35 Mo, and 0.50 to 0.60 per cent C. It should be normalized, tempered, and drawn to about 50 Rockwell C. A somewhat harder material is necessary for upsetters and forging-presses.

Die design should allow for distribution and flow of the metal into the flash, and as little flash as possible should be produced. Proper grain flow in the forging is essential where high compressive strength is desired.

For fairly large forgings, separate die-blocks are used for blocker and impression. Properly designed blocking die will aid production of clean, sharply defined, and completely filled final forgings without "cold shuts" and other irregularities.

Heating for Forging

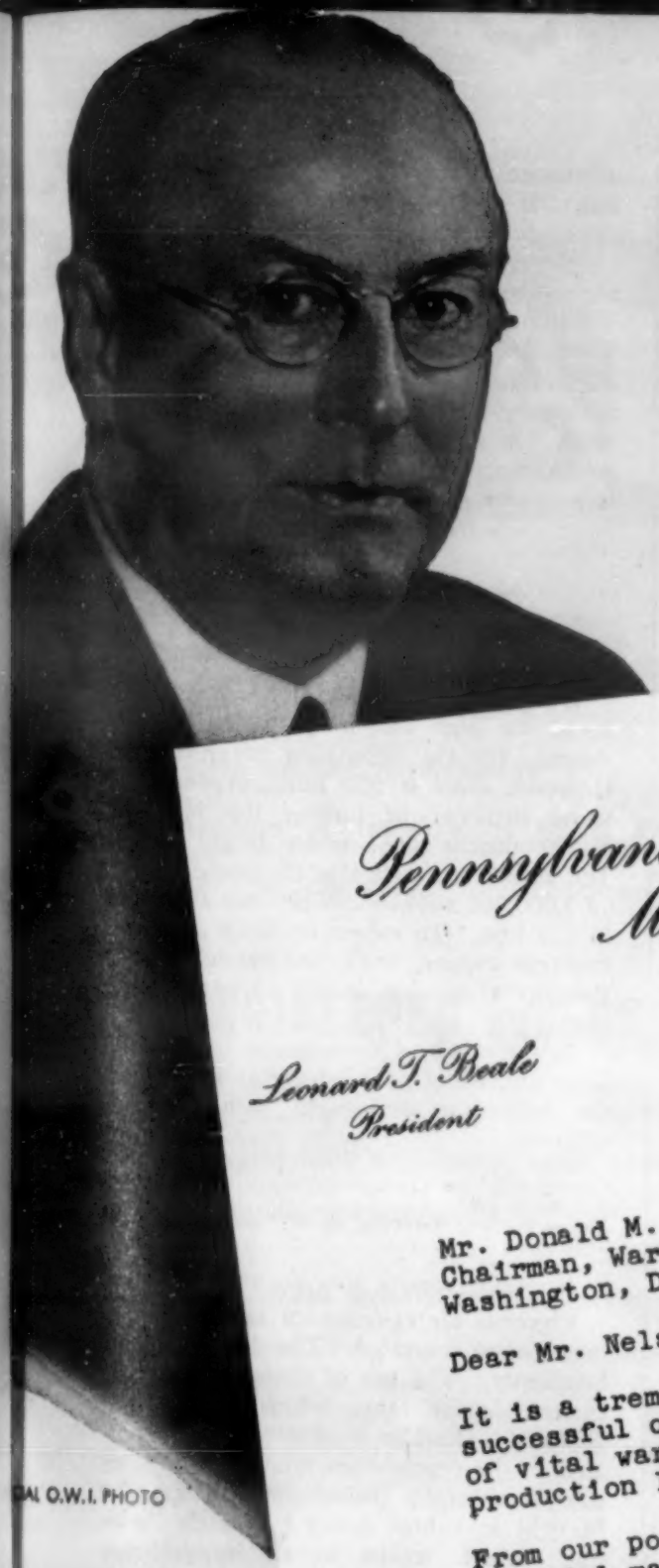
In heating stock for forging, maximum forging temperatures must not be exceeded. These are 800 deg. F. for 32 S, 820 deg. F. for 18 S and 73 S, 840 deg. F. for 14 S, 17 S, and 70 S, 860 deg. F. for 25 S, and 880 deg. for A 51 S. In upsetting 18 S and 32 S, temperature may be 880 to 900 deg. F. It is often desirable to work aluminum at lower temperatures, however.

A slight thickness allowance, applied to the overall depth of the forging in a direction perpendicular to the parting plane and parallel to the traveling direction of the ram, is permitted when hammer forging aluminum alloys. This allowance is proportional to the forging's weight.

Tolerances are — 0.010 in., + 0.032 in. for 0 to 0.25 lb.; — 0.015 in., + 0.032 in. for 0.251 to 1 lb.; — 0.032 in., + 0.045 in. for 1.01 to 4 lb.; — 0.032 in., + 0.062 in. for 4.01 to 17 lbs.; — 0.032 in., + 0.078 in. for 17.01 to 24 lbs.; and — 0.032 in. and + 0.093 in. for 24.01 lbs. and up. Any deviation from these tolerances will necessitate the use of a complete cold restriking die or coin-press dies. Thickness tolerances must be applied independently of any other tolerances.

Allowance should be made for shrinkage and a small amount of mismatch (faulty alinement of top and bottom dies). Shrinkage tolerance is + 0.004 in. and — 0.002 in. for each inch of length or width, except that for 4 in. the + tolerance is 0.014. in. Mismatch tolerances are 0.015 in. for net weights up to 2.5 lbs., 0.018 in. up to 6.25 lbs., 0.021 in. up to 8.5 lbs., 0.024 in. up to 15 lbs., 0.028 in. up to 20 lbs., and 0.032 in. up to 25 lbs., and over.

Calculation of shrink and mismatch tolerances must be made in conjunction with each other; never as the sum of the two. Whichever of these requires the greater



OFFICIAL O.W.I. PHOTO

IT'S A TREMENDOUS JOB YOU'RE DOING, MR. NELSON

Incorporated 1850

Pennsylvania Salt Manufacturing Co.
Manufacturing Chemists.
Widener Building
Philadelphia

Leonard T. Beale
President

December 19, 1942

Mr. Donald M. Nelson
Chairman, War Production Board
Washington, D. C.

Dear Mr. Nelson:

It is a tremendous job you are doing. And a remarkably successful one to date, as evidenced by the huge volume of vital war supplies that is now rolling off American production lines.

From our position as but a single unit in the vast industrial march to victory, we have some appreciation of the immense problems and responsibilities that you and the War Production Board face in coordinating national production.

We know the task has just begun. We realize the imperative need of teamwork and cooperation. In supplying essential chemicals to key war industries we sometimes feel that we are playing only a limited part in the war program -- although there is no limit on our effort.

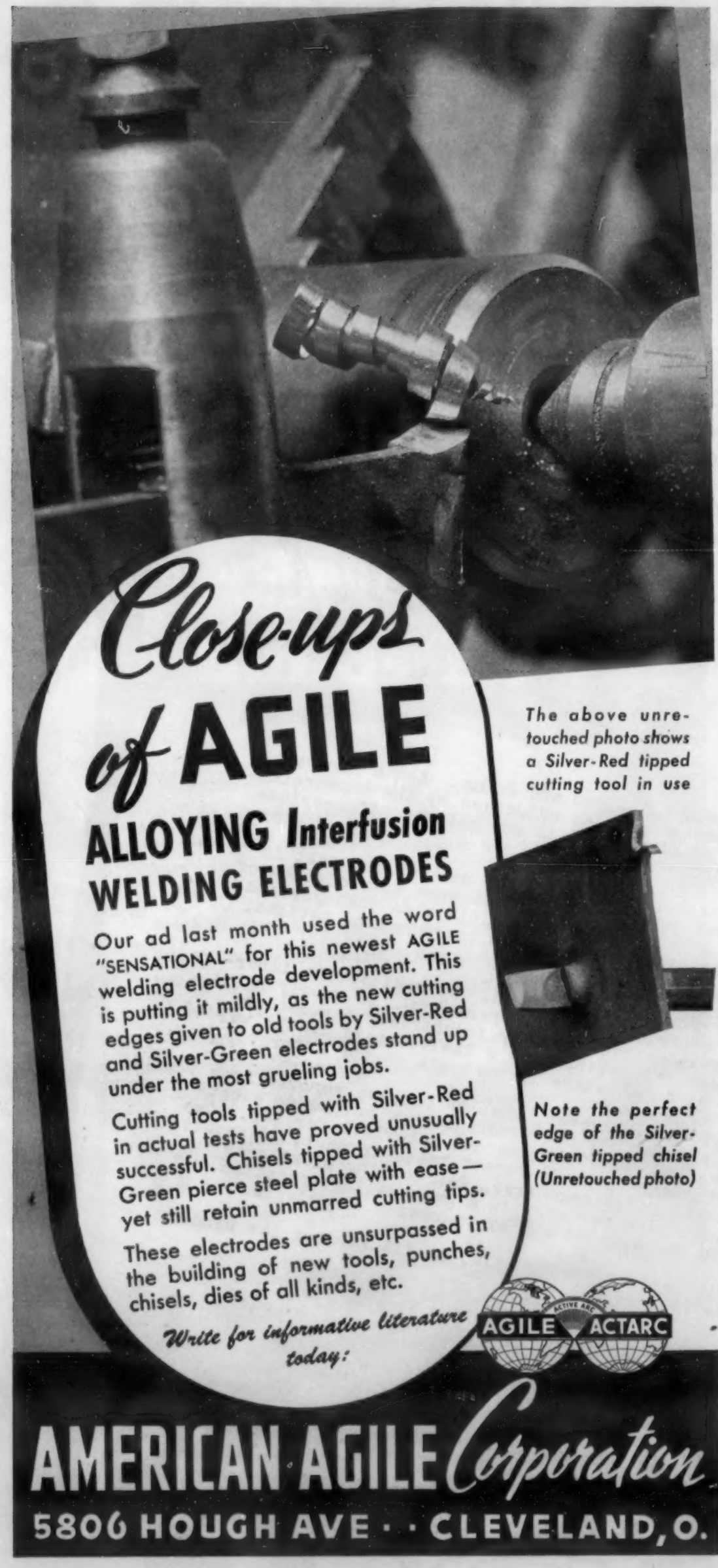
We are gratified, however, when we receive reports from the field showing how our products have helped do a better and faster job of turning out materials for war. One such routine serviceman's report read, in part, "Pennsalt Cleaner saved this large steel fabricating plant over 5000 lbs. of zinc per week in a galvanizing operation. Production was speeded 25% by reduction of rejects."

While this is just one example, it illustrates the kind of job we like to do.

Yours for Victory,

Leonard T. Beale

PENN SALT
Chemicals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Our ad last month used the word "SENSATIONAL" for this newest AGILE welding electrode development. This is putting it mildly, as the new cutting edges given to old tools by Silver-Red and Silver-Green electrodes stand up under the most grueling jobs.
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The above unretouched photo shows a Silver-Red tipped cutting tool in use
Note the perfect edge of the Silver-Green tipped chisel (Unretouched photo)
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allowance in a given direction should govern. If it is necessary to provide extra stock for finish machining, such metal should be in addition to that allowed for mismatch and shrinkage.

Among the most popular lubricants for preventing excessive sticking of metal to dies are salt water, graphite in oil and molten beeswax. Last is probably the most ideal, but is expensive. However, it is used extensively on forging-presses because it promotes ease of operations.

—*Heat Treating & Forging*, Vol. 28, Sept. 1942, pp. 462-467, 483.

Bright Copper Plating

Condensed from "Metal Finishing"

The use of bright nickel has greatly reduced the high cost of preparing electrodeposits for the deposition of chromium. However, there is still much expense and waste involved in buffing the layer of copper usually used under bright nickel. The authors estimate that the buffing losses on 2,000,000 automobiles per year amounted to 625 tons. To reduce finishing costs and conserve copper, work was carried out to develop a suitable bright copper plating bath.

As the result of experiments in which a large number of addition agents were tried, the following semi-bright bath was developed:

	grams per liter
Copper sulphate	250
Sulphuric acid	10
Triton No. 720 (wetting agent)	0.2
Thiourea	0.01
Temperature, deg. F.	70 to 80
Aver. current density, amp. per sq. ft.	48

Vigorous air agitation or cathode movement is recommended. The thiourea is the brightener. The use of Triton widens the current density range which gives bright deposits. The above solution, when operated in the temperature range stated, gives soft semi-bright deposits which can be brought to a high luster by merely "wiping," which results in an inappreciable loss of copper. If the bath temperature is reduced to 55 deg. F., mirror bright deposits are obtained. Raising the temperature to 80 to 100 deg. F. results in loss of most of the brightness but only slightly affects the buffing qualities of the deposits.

A licensee of the semi-bright process found that the use of molasses decreases the tendency for striations to appear in low current density areas. With its use, brighter deposits requiring no buffing at all are obtained. A typical bright copper bath containing molasses has the following composition:

	grams per liter
Copper sulphate	210
Sulphuric acid	30
Molasses	0.80
Thiourea	0.04
Temperature, deg. F.	70
Current density, amp. per sq. ft.	70 to 75

No satisfactory methods of analysis have been developed for the addition agents, but empirical control by visual inspection of the deposits has proved satisfactory.

Anode area should be as large as possible. As much as 30 g. per l. of iron can be present in the bath without affecting the luster of the deposit. However, if this much iron is present, the increased resistivity of the solution makes temperature control difficult. X-ray studies of the deposits show them to be very fine-grained

DC Power

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HERE is a personalized power source for Direct-Current—designed with all the requirements of every metal worker in mind—by the makers of the famous SELECTRO-PLATER and other industrial rectifier equipment for DC power

ENGINEERED and BUILT to match any specified AC power supply.

To give high efficiency, unity power factor and unlimited life with negligible maintenance . . .

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An outline of your DC power problem will bring you detailed specifications and recommendations promptly.

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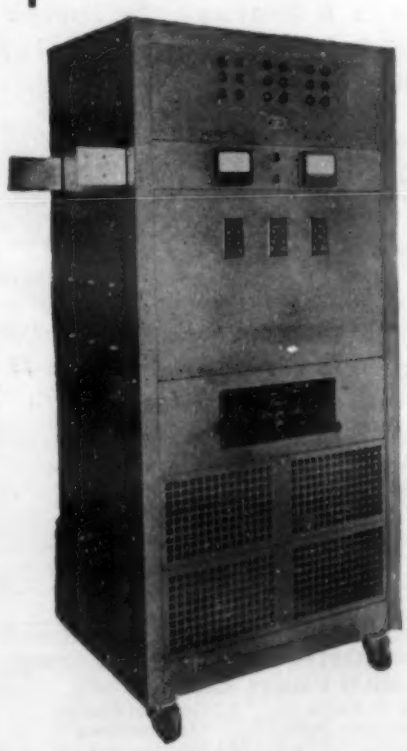

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and to have a structure in which the crystals are oriented parallel to the metal surface. Photomicrographs of the deposits show that they have a layered or laminated structure.

—F. L. Clifton and W. M. Phillips, *Metal Finishing*, Vol. 40, Sept. 1942, pages 457-462.

Electrodeposited Paint Spray

Condensed from "Proceedings," American Electroplaters Society

This is a description of a novel development in spray painting. The object being painted is surrounded by suitably designed and located electrodes and the object itself is grounded. A high potential of the order of 100,000 volts with respect to the ground is then applied to the surrounding electrodes.

The particles comprising the paint spray acquire an electric charge on entering the field and are attracted to the object being painted. Paint particles which have traveled beyond the object can actually be seen to stop, reverse their direction, and deposit on the back of the object.

Large Savings of Paint

It is claimed that the use of the process results in large savings of paint and in the deposition of a paint film of more uniform thickness than is produced by ordinary methods.

Direct current is essential, although fair results are obtained with almost any rectified wave form. Half-wave rectification is as good as any. Power requirements are low since in no case is the secondary current more than 4 or 5 milliamperes.

The spray guns used are of a standard make, but may require different adjustment of tip size, pressure, etc. than when used for the usual method of spray painting. The position of the spray guns is important. If high paint savings are to be realized, the axis of the gun must be directed at an acute angle to the line of travel of the pieces on the conveyor.

The paint required for this process is in no way different from that used in general finishing work. However, it is necessary to adjust the solvents so that the film remains open a little longer than normal usage would require, and the viscosity should be less than that of paint used for ordinary spraying.

The process is not limited to articles made of conductive material. Very efficient results can be produced on both wood and pottery. In the painting of over 1,000,000 pottery flower pots by this method, paint consumption was one-fifth the amount used when spraying by hand. It is believed that 40 per cent savings will be realized on objects such as refrigerators.

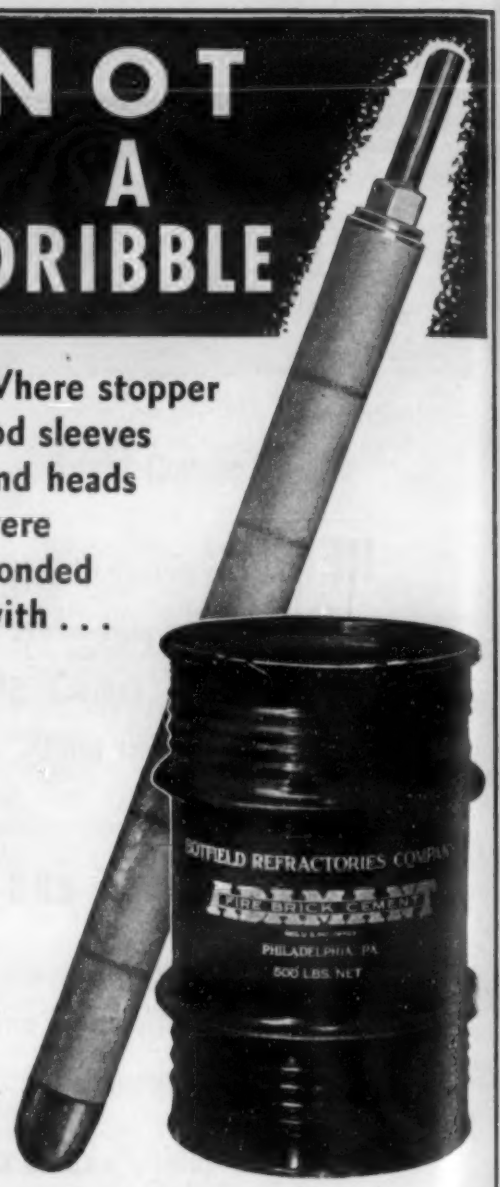
There are a few limitations to the use of this process. Protruding edges and recessed sections are difficult or impossible to coat uniformly. A considerable volume of repetitive production is necessary before it is practical to install the highly specialized equipment required.

Removing Excess Paint

Another process is described which aids in removing "fatty edges" and excess paint from the "drain-off" point of pieces that have been dipped. The dipped article is

NOT A DRIBBLE

Where stopper rod sleeves and heads were bonded with . . .



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"Harnimoly's" place in our production will be taken by other P&H Alloy Electrodes more urgently needed in wartime service. These include types for hard surfacing, resistance to wear, impact and abrasion; for welding stainless steels, 4-6% chrome steels, armor plate, etc. To join in hastening the day of Victory, P&H is supplying electrodes in unprecedented volume to vital wartime industries.

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first allowed to drain until the flow of paint has almost stopped. It is then passed over an electrode charged to about 60,000 volts. The excess paint is attracted from the piece.

Use of this process should make possible a wider use of dipping instead of spraying, and a wider range in the formulation of dipping materials. It will make unnecessary the costly practice of "cutting off" and patching areas around drain-off points.

The process is not limited to materials normally considered conductive. Pottery, rubber, bakelite, and glass have been successfully processed, using insulating coatings such as high dielectric varnishes, latex, and wax, as well as normal types of organic finishes.

—Harold Ransburg, *Proc.*, Am. Electroplaters' Soc., 1942, pages 62-65.

Electrodes for Aircraft Welding

Condensed from "Welding Journal"

This article is a report of tests made for Army Air Forces Material Center, Wright Field, on 20 different electrodes to determine the handling characteristics of the various commercial electrodes which are being used or had possibilities for use, in aircraft welding. Plain carbon steel electrodes were chiefly studied although three alloy steel electrodes were also tested. The work was limited to tests in which d.c. welding machines were used. Most of the tests were made with 5/64, 3/32 and 1/8-in. electrodes.

A Chromium-Moly Steel Used

The steel used in all the welding tests was S.A.E. 4130 aircraft quality plate, sheet and seamless tubing. The tests made included single fillet Tee joints, butt welds in plate and seamless tubing, weld-bead deposits, spotter tests, and tube cluster joints. The last named was found to be the most satisfactory single test. Check tensile tests for quality, hardness traverses and X-ray and Magnaflux surveys were used for additional information.

Data obtained included observation of ease of starting and smoothness of arc, penetration, undercutting tendency, mobility of slag and weld metal and contour and surface smoothness of the weld deposit. On the basis of tests performed, electrodes of the E6012, E6013 and E7012 classes gave the highest efficiency rating and would be judged to be satisfactory for present practice.

The class E6010 electrodes were noticeably less satisfactory, as they produced excessive penetration, tended to undercut and were harder to handle, especially in the "vertical down" position. The class E7020 and E7030 electrodes were quite unsatisfactory from the point of view of general utility. This is not surprising or important because they are designed for a different use.

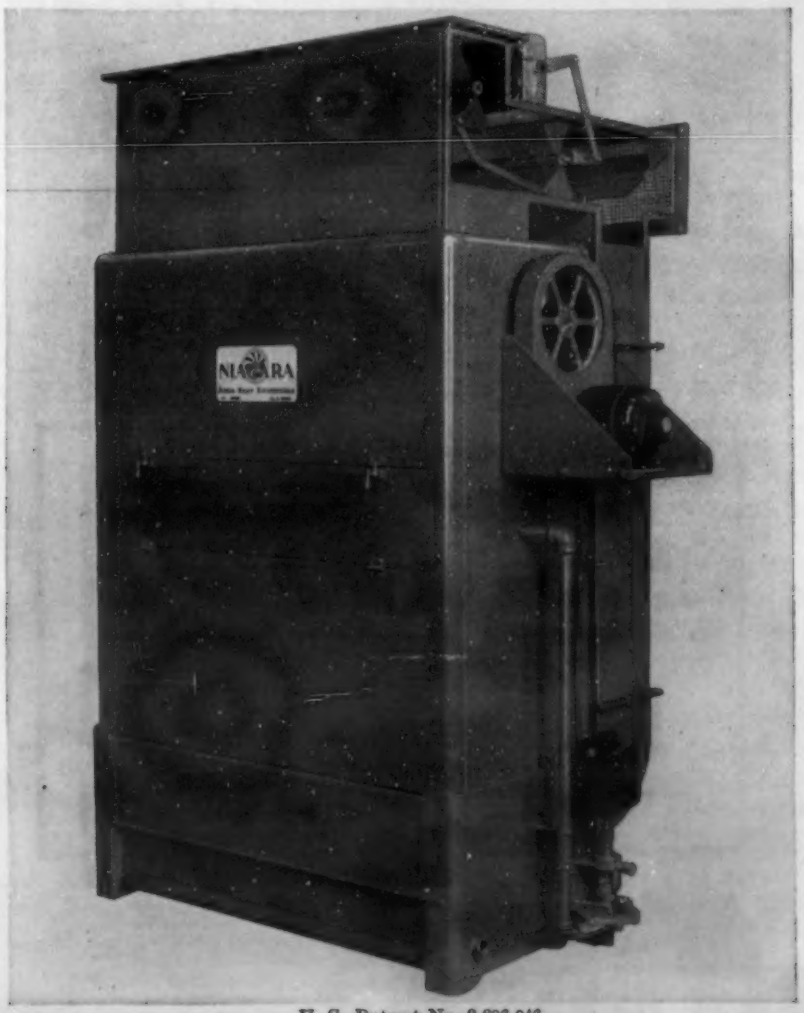
The Alloy Electrodes

The alloy aircraft electrodes were in general less satisfactory than the plain carbon steel electrodes; two, which were still in the stages of development, were definitely unsatisfactory, while the third was harder to use and had a deeper penetration than was desirable. Results of tests of the three alloy steel electrodes indicated that they offer no advantage except when the welded assembly is to be heat treated and high strength in the welds is required.

In spite of the generally favorable results with certain classes, none of the electrodes had all the characteristics desirable in a completely acceptable aircraft arc-welding electrode. In some instances where either could be used, smaller diameter electrodes rated higher than larger ones for aircraft welding, because the increase in ease of handling of the smaller ones more than compensated for the decrease in efficiency.

No single and conclusive test has yet been developed for determining all the important handling characteristics of aircraft arc-welding electrodes, but it is believed that the double tube triangle specimen proposed by a sub-committee of the Aircraft Welding Research Committee (Section H of the Industrial Research Division) for weldability tests of aircraft steels embodies most of the features of a suitable test specimen and at the same time is closely representative of actual tubular aircraft joints.

The ratings for the electrodes are presented in several tables on the basis of the fillet weld Tee joints in 1/16-in. sheet; of penetration; of cluster joints made at room temperature and with 400



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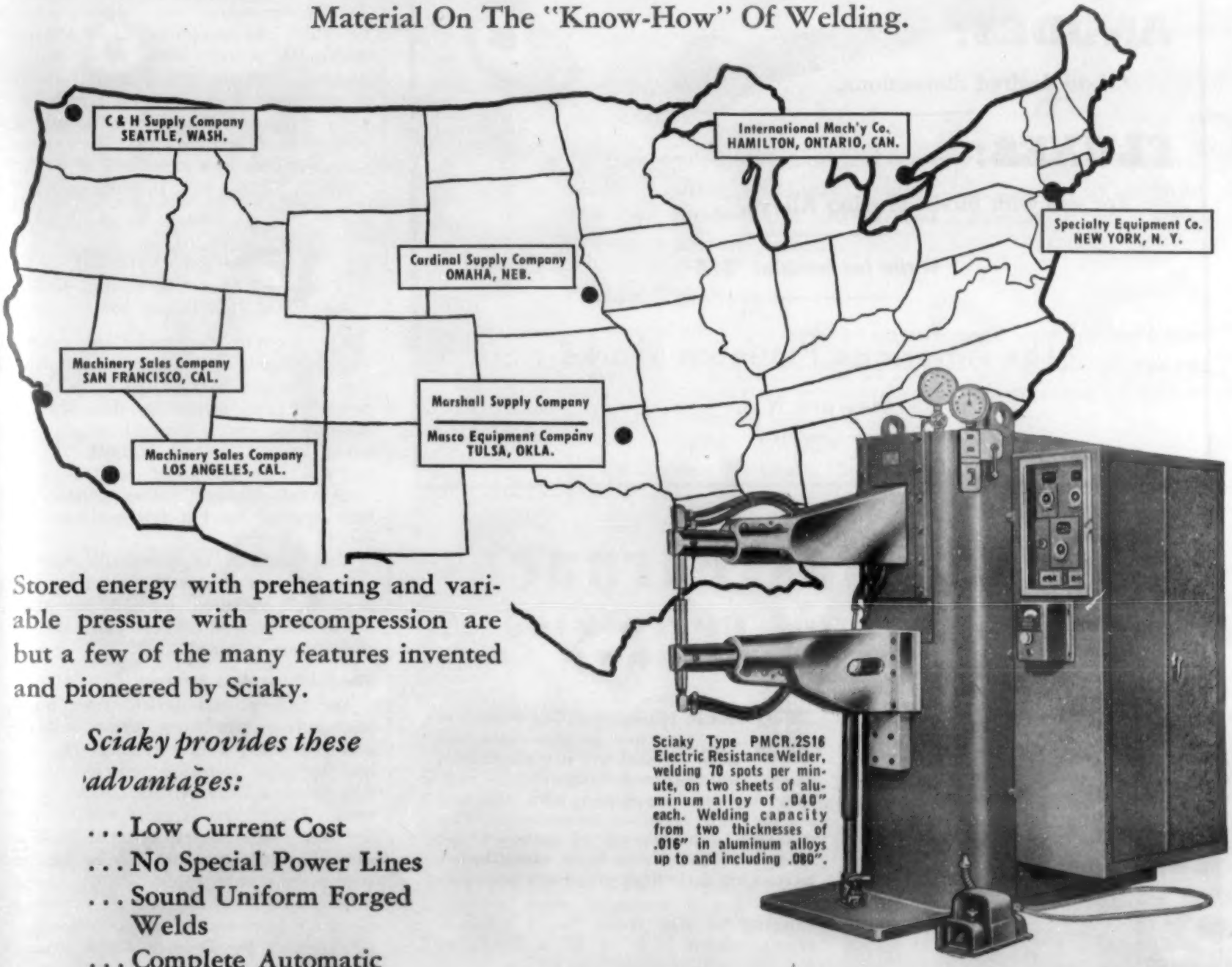

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Also many other standard and special compositions.

ANODES:

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For use with Silver Brazing Alloys.

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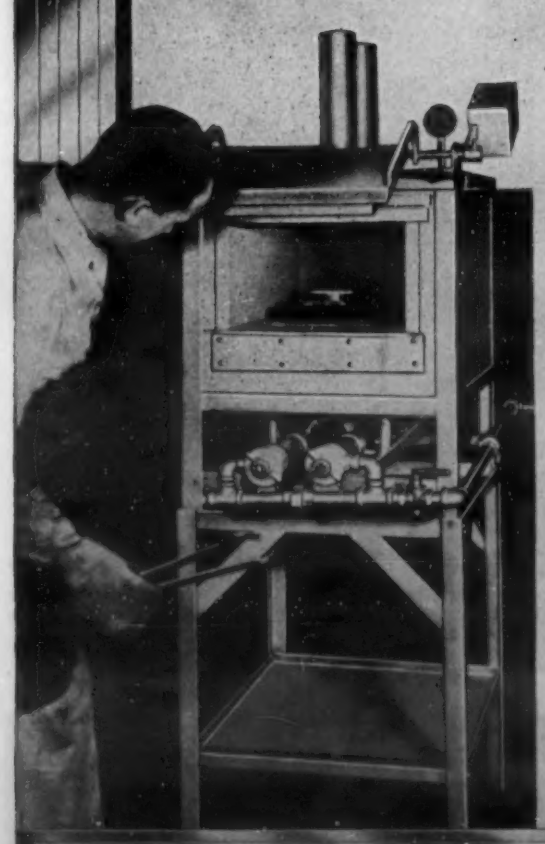
TEMPERATURES UP TO 2400° F. WITHOUT A BLOWER



BAKER Blowerless Gas Furnaces are very low in gas consumption, noiseless in operation, reach the required temperature rapidly and are equipped with thermocouple and accurate pyrometer. The research departments of some of the largest corporations have contributed to making their high efficiency possible.

There are 9 standard stock models ranging in size from No. 1 (Bench type), which is 6" x 8" x 5½", to No. 24, which is 12" x 20" x 8" as illustrated. All provide uniform, controlled heat up to 1900° F.

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We stock one Hydrogen Atmosphere furnace, No. 12, with a closed muffle 8½" x 15" x 2½" high.

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to 500 deg. F. preheat, vertical fixed position; of cluster joints made at room temperature, inclined position and composite rating for all characteristics not including tensile properties, internal porosity and cracking tendency. In the latter table the range is from 83 to 60 per cent for the carbon steel electrodes and 82 to 62 per cent for the alloy electrodes.

Some Conclusions

Among the conclusions, the authors say that it is most fortunate that an adequate number of satisfactory electrodes is available from which to choose. It should not be considered a detriment to the general merit of an electrode if it is found unsuitable for aircraft use. Almost without exception, the electrodes now used most widely in aircraft work were originally designed with no special aircraft purpose in mind, and it is not to be expected that every electrode in a class or group will perform to its best advantage when applied, or misapplied, in a new field of welding.

—C. B. Voldrich & R. D. Williams, *Welding J.*, Vol. 21, Nov. 1942, pp. 540s-553s.

Anodizing in Germany

Condensed from "Die Dornier Post" (abstracted in "Aircraft Production")

The discovery that under the action of the air, aluminum becomes coated with a thin protective layer of oxide, led to experiments for increasing this layer by chemical or electro-chemical means. The oxide coating protects against corrosion and makes the aluminum more resistant to mechanical damage. Many patents have been applied for but few processes have proved effective.

The resistance of chemically produced oxide coatings is strictly limited but with electrolytic oxidation, more or less elastic absorbent as well as corrosion resistant coatings are obtained.

The Sulphuric Acid Process

The G.S. process (Gleichstrom Schwefelsäure, *i.e.*, continuous current sulphuric acid process) produces coatings characterized by great corrosion resistance, which take on remarkably brilliant shades if colored. The process is rapid and the voltage low. All aircraft material made of aluminum and its alloys can be oxidized at about the same speed.

Copper reduces the rate of growth of the oxide layer and in alloys containing it (duralumin) the Dornier works increases the voltage to obtain the normal rate of growth. Hydronalium, especially in the welded state, requires both a reduction in current density and periods of oxidation. This also applies to very porous castings of aluminum and its alloys, as prolonged exposure in the G.S. bath at excessive voltage causes pitting.

Before immersion the parts are cleaned and degreased. They are then mounted — *i.e.* provided with contacts by means of aluminum or duralumin wire or other appliances of those materials. Parts lying flat on top of each other are not coated at the point of contact. Therefore the electrical contacts must be as small as possible and yet sufficiently large to prevent excessive heating and burning of the material. Suitable attachment devices assure

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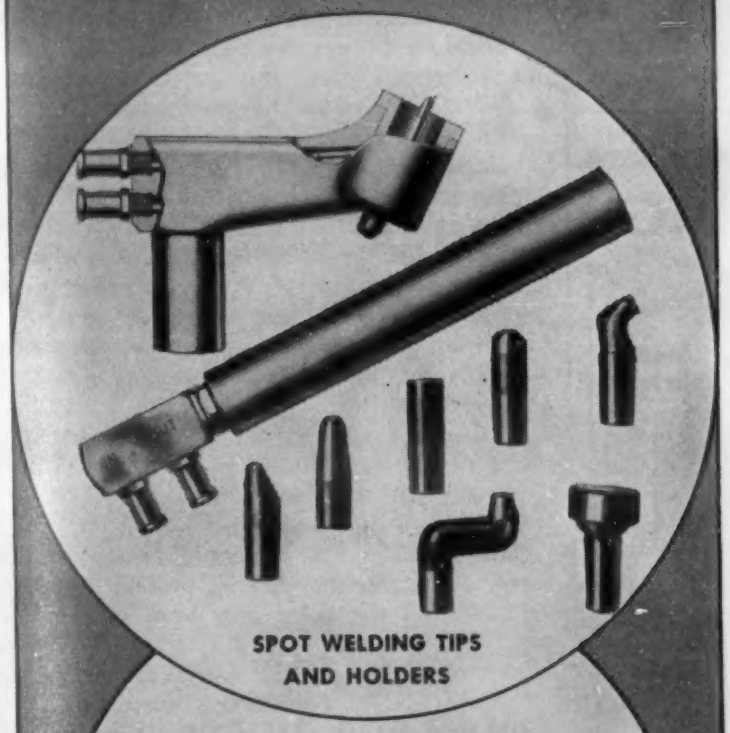
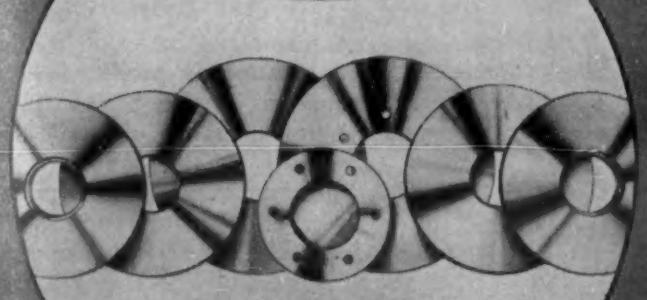
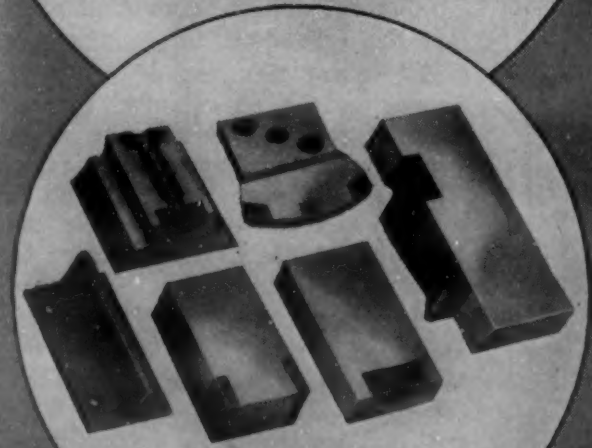


SPOT WELDING TIPS AND HOLDERS



SEAM WELDING ROLLS



FLASH, BUTT, PROJECTION WELDING DIES

Speedier Production
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Better Welding
Lower Cost

How to Dress Spot Welding Tips and Save Vital Raw Material

You'll save production time and conserve essential raw materials . . . do a better resistance welding job, too . . . by insisting that spot welding tips are dressed correctly in your plant. Here are some suggestions:

Three "Do's"

1. Machine Tips to Size on any small lathe having a suitable collet or quick-acting chuck. A day's supply of tips can easily and quickly be machined . . . and machining on a lathe is the best dressing practice.

2. To Dress Tips on the Machine . . . and thus avoid down time on a long production run . . . use the Mallory Tip Dresser illustrated above. This handy tool re-machines both upper and lower tips to the correct welding face, with no need for removing tips from their water-cooled holders. Or, if a flat tip is being used opposite a pointed or domed tip, the latter can be dressed by inserting a plate between the Tip Dresser and the flat tip.

3. Clean the Surface of electrodes at frequent intervals with a fine abrasive cloth. Use this cloth lightly and don't permit it to become contaminated with iron particles or other dirt that may "burn" the electrode.

A "Don't": In general, do *not* use an ordinary shop file to dress spot welding electrodes. Also, a clogged or dirty file will shorten electrode life by contaminating the electrode.

TECHNICAL DATA SPEEDS PRODUCTION.! Selection of the best electrode materials, designs and cooling methods for spot, seam, flash or butt or projection welding . . . it's not easy . . . but the right answers in any specific application will certainly speed output. Mallory metallurgists and welding engineers can give you the right answers to your problems on resistance welding. They'll help you produce better welds, faster, at lower cost. Write today for specific data . . . and for your free copy of the useful 79-page MALLORY RESISTANCE WELDING DATA BOOK.

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perfect anodization for sheets of any size and thickness.

During oxidation there is evolution of oxygen and hydrogen, which must not be trapped in cavities, because the electrolyte would then be expelled from them. Hollow spaces, as in containers, must have the opening facing upwards. Work-pieces, in which the hollow space is deeper or greater than twenty times the diameter of the apertures, must be fitted with auxiliary cathodes, properly insulated.

After mounting, the parts are pickled in a mixture of hydrofluoric and nitric acid to remove remaining dirt and the natural coating of oxide, until the surface becomes pure white. After rinsing in cold water, the parts are suspended in the bath and the contacts screwed up with the anode.

The Bath Concentration

The concentration of the bath is determined by titration. A rise in the sulphate content, from the aluminum dissolved in the bath, must be balanced by an increase in voltage. Beyond 45 grammes per litre, this cannot be done and a fresh solution is necessary. If the bath concentration is too low, concentrated sulphuric acid must be added.

The bath temperature should be between 16 and 24 deg. C. (60.8 and 75.2 deg. F.) The voltage varies between 11 and 22 volts, depending on the nature of the specimen, the concentration of the bath and the temperature of the electrolyte.

The temperature of the electrolyte is maintained by cooling water flowing through aluminum pipes. If the temperature of the cooling water becomes too high to make this possible, the bath voltage must be reduced.

When the process is completed the current is turned off and the specimen removed as quickly as possible and rinsed for 10 to 20 min. in running water to remove the acid from the pores of the oxide. Next the pores are sealed in a hot potassium bichromate solution. The yellowish-green color this produces acts as evidence of satisfactory anodization.

After drying, all specimens requiring painting are immersed in very thin dipping-varnish, to eliminate the small degree of absorption retained by the oxide. The varnish leaves a very thin film which cannot be scraped off, is redissolved in the paint and forms a firm anchor for it.

Pipes, placed in an aqueous solution of aniline dye, take on an identifying color, largely gasoline, oil and water resistant. If they are cold-shaped, pipes up to 10 x 1 can be treated as straight pieces. The varnish will not crack with further cold working. Pipes of larger diameter and those worked hot can only be anodized and dyed after the shaping process is completed and the color may burn off.

The Oxalic Acid Process

The G.X.H. (continuous current-oxalic acid process) is used for the production of highly absorbent and corrosion resistant layers. This coating is produced in 40 min. on aluminum of the highest purity using an electrolyte mainly of oxalic acid, with a current of 30 to 35 volts. The electrolyte must have a temperature of 35 to 45 deg. C. (95 to 113 deg. F.) and the current density should amount to 1-5-2 amps. per dm.^{2} The strong absorption of the layer is used under the name "Seo Foto" for the deposition of photosensitive substances.

Subsequent treatment of such layers is similar to the photographic process and is used for the manufacture of highly corrosion and heat-resisting sign plates. These color plates do not fade and possess a very high abrasion resistance. Halftone photographs can be produced by this method.

The success of the electric oxidation of aluminum and its alloys is due to the fact that no foreign metal is deposited. The coating of oxide is formed from the metal itself. Tiny pores in the coating reach down to the basic metal. This porosity makes possible the deposition of thicker layers. The coating of oxide grows more slowly as its thickness increases. After a certain point, the old layer is dissolved and replaced by a new one. Therefore it is impossible to produce layers of arbitrary thickness. As applied to aircraft materials the maximum thickness is approximately 30/1,000 mm.

An advantage of this is that, if instructions are observed, thin cover sheets cannot be completely converted into oxide. Two-thirds of the oxide layer is formed

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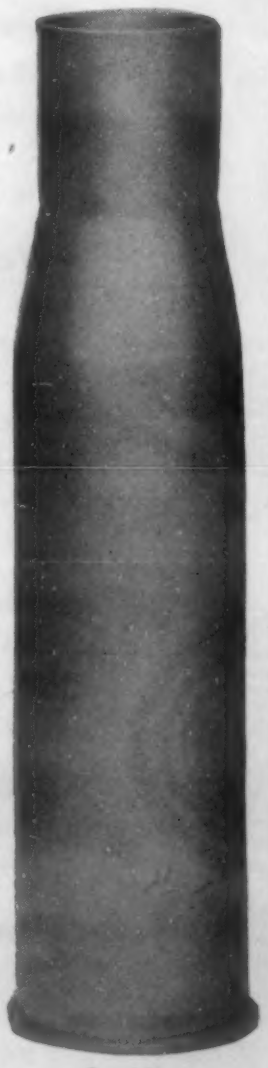

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"Where do you get the POTS for your FURNACES, Mr. Barstow?"

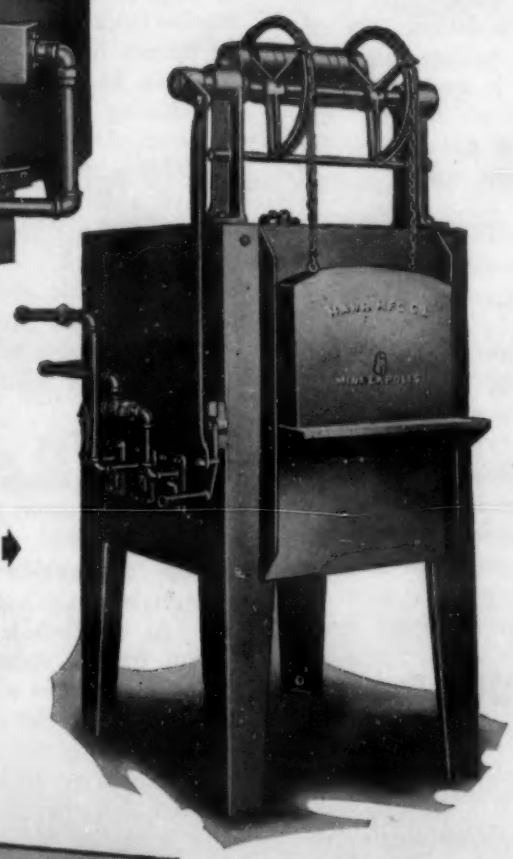
That question was recently asked of our Mr. W. G. Barstow by an executive of a large aviation manufacturer. Here are the facts:

The pot in the particular MAHR furnace used by this manufacturer had been in operation for *six years* before it needed repair. After repair, it had been operating a year. The executive naturally considered that the pot was made of some wonderful material. Actually, it was made of ordinary boiler plate! The reason for its long life, as Mr. Barstow showed, is the unusually successful MAHR *method of firing.* In view of this incident, it would be trite to say this man appreciates the value of MAHR Furnaces.

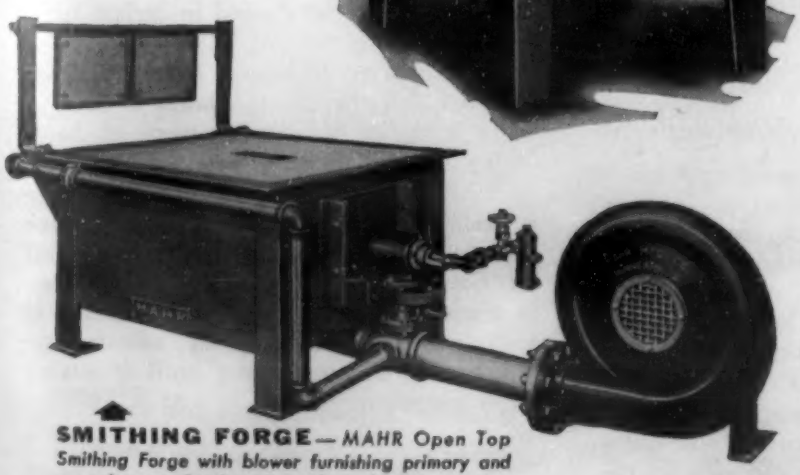
For over a quarter century, MAHR has built furnaces on the premise that "there is NO substitute for quality and sound engineering". Perhaps, on occasion, a MAHR Furnace may cost a trifle more. But if the engineered performance-ability gives longer life and higher quality of production, a far greater additional cost would be well justified.

Ask us for the names of MAHR users over the years. Ask us also about the type of furnace YOU need. See the list of types in box. A MAHR Engineer can help you on any heat treating problem—wire, write or phone today.

POT FURNACE
MAHR Standard Pot Furnace with hood for cyanide, etc. Made in many sizes and types, including rectangular type for molten bath. These furnaces are specially designed for longer pot life—often as much as 25% to 50%!



TOOL FURNACE—*MAHR Standard Tool Furnace. Under fired to 1800° F. for regular tool steels. Over and under fired to 2600° F. for high speed tool steels.*



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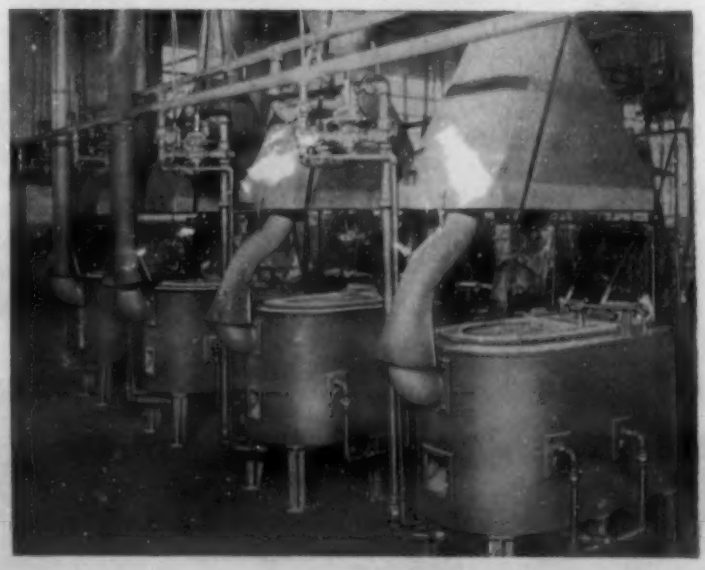
MAHR Lead Pots in hard use in a large battery manufacturing company's plant.



MAHR FURNACES FOR EVERY HEAT TREATING NEED

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Annealing	Car Bottom	Rivet Forges
Carburizing	Pit	Torches
Baking	Pusher	Burners
Hardening	Roller Hearth	Blowers
Forging	Continuous	Valves
Drawing	Pot	Smithing Forges
Stress Relief	Rotary	

KOLD-HOLD Rivet Machine

Cuts Rejects!

Keep aluminum alloy rivets in anneal at –45° F. and cut inspection rejects as much as 10% to 50% . . . with KOLD-HOLD Rivet Storage Machines.

Stored rivets drive faster, are less subject to head cracks — fewer have to be drilled out and replaced. Speed production, too, with rivets stored right where they are used. Handy tube assembly classifies rivets—permits storage up to moment of use.

Where large quantities of rivets are used, large KOLD-HOLD rivet storage units are at annealing stations, and small portable KOLD-HOLD units carry rivets to departments.

Whatever your rivet storage or industrial sub-zero processing problems may be, investigate KOLD-HOLD. Get complete details, NOW.

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inside the basis metal by inward growth. Therefore specific dimensions are not strictly retained but so far that has not proved detrimental.

The electric disruptive strength of the coating is very great. This would be detrimental to radio equipment if it were not possible to bond all the structural components of an aircraft. A perfect electric connection is established by the rivets and screws and also because all bore holes on anodized parts are made before assembly or redrilled. In the electrical industry the oxide layer is used as an insulating agent for aluminum wires. This insulating action makes it easy, in inspection, to check any flaws with a torch battery and bulb.

Welding Not Possible

Anodized materials cannot be welded as melting point is four times higher than that of aluminum. If anodization shows up cracks, so that re-welding is necessary the parts must first be de-anodized in a hot caustic soda bath or a nitric-fluoric acid pickling bath.

Electric oxidation shows up cracks and inclusions both after the preliminary pickling and during actual oxidation. In expensive work requiring milling, shaping, and turning, the process is applied to unfabricated material to detect faults. Extensive machining should not be carried out on anodized specimens unless re-anodization is possible.

Fabrication of anodized parts is only permissable if done without annealing or subsequent heat treatment, or if the parts are de-anodized.

A specimen can be anodized in 1½ hrs., gaining a protection against corrosion equal to three layers of lacquer. It can be riveted immediately and the oxide will not crack at the rivet points. A single coat of paint provides camouflage, recognition marks, and protection for rivets.

Improvements at the Dornier works have reduced the cost of this process to one-quarter that of a three-layer lacquer coating.

—Aircraft Production, Oct. 1942, pages 604-607.

Small Tool Reclamation

Condensed from "The Welding Engineer"

Today the oxy-actylene welding torch is performing hundreds of operations in maintaining and fabricating shop tools, without which production speeds would be impeded seriously.

For example, extra long heavy-duty reamers, used to ream locomotive frame bolt holes, receive rough usage. The tang is often snapped from the tapered end of the reamer, which is expensive and today irreplaceable. The welder can rebuild the tang after which the end is ground or machined back to size.

The welding of reamers, as of drills, requires a high degree of skill. All cracks must be removed and all checked pieces either ground or chipped from the broken tang. A mild steel rod is used for the welding and carburizing (excess acetylene) flame must be maintained at all times.

Welding must start as soon as the heated end of the reamer becomes molten and the puddle must be ready to receive the filler metal. Working the metal with the flame must be avoided as it burns up carbon, reducing the high quality of the steel. If the puddle is sluggish, adding a few grains of cast iron flux will dissolve the oxide and free the metal.

Regulating Correct Dimensions

One of the most important points in tool reclamation is to check frequently to be sure that the deposit being added will grind or machine to the correct dimensions. Too little added will necessitate "re-doing" and too much wastes time and labor.

This procedure also is used successfully in making extension drills (high speed drill bits welded to long shanks). A simple fixture is employed to align the parts. An example is a ⅜ in. high speed drill flame-welded to a mild steel shank, which is used to bore oil holes in giant wrist pins, often drilling 12 to 14 in. through a top grade of steel.

If a drill or reamer must be used in an inaccessible position, an extension may be made by welding male and female collets to a piece of pipe or bar. With the extension socket in the motor and the drill or reamer in the socket, drilling or reaming may be accomplished 4 or 5 ft. from the driving force.

A radical arrangement of this type is used in welding the superheater flues in the fire box of a boiler. Because of the limited space in the fire box, those flues are usually rolled by hand. The new arrangement of heavy-duty male and female collets, flame-welded to a 12 ft. piece of 1½ in. pipe, makes it possible to roll the flues in minutes instead of hours.

Brazing Tool Tips

Cemented carbide tools of odd shapes and sizes are made by buying carbide tips, forging the tools, milling out the seat for the tip and brazing it into place with an oxy-acetylene torch and a bronze welding rod. As the carbide tip and the tool steel do not have a strong affinity for bronze, any foreign matter will spoil the bond. Both should therefore be dipped in carbon tetrachloride before brazing.

A light layer of bronze is deposited on the tool and tip and the latter is held in place with an old file or piece of hard-facing rod. The flame brings both pieces gradually to a red heat and as the bronze begins to flow, pressure is applied to force the tip into the seat and squeeze out all air bubbles. When set, the entire tool is buried in some heat control material such as lime or chopped asbestos or wrapped in asbestos paper until it attains room temperature.

Hard Facing

A deposit of hard-facing on the tip of a machine tool often enables the machinist to complete an otherwise impossible job. There are two methods of application. One is fusion and the other, the sweating method. The latter is preferred because of the small amount of inter-alloying encountered.

In this method, the part to be coated is brought to a dark red heat. As the metal changes from a dull to a shiny appearance, the surface seems to become

FIRTHITE POINTS THE WAY TO SAVE ALLOYS

EXTRAVAGANT!

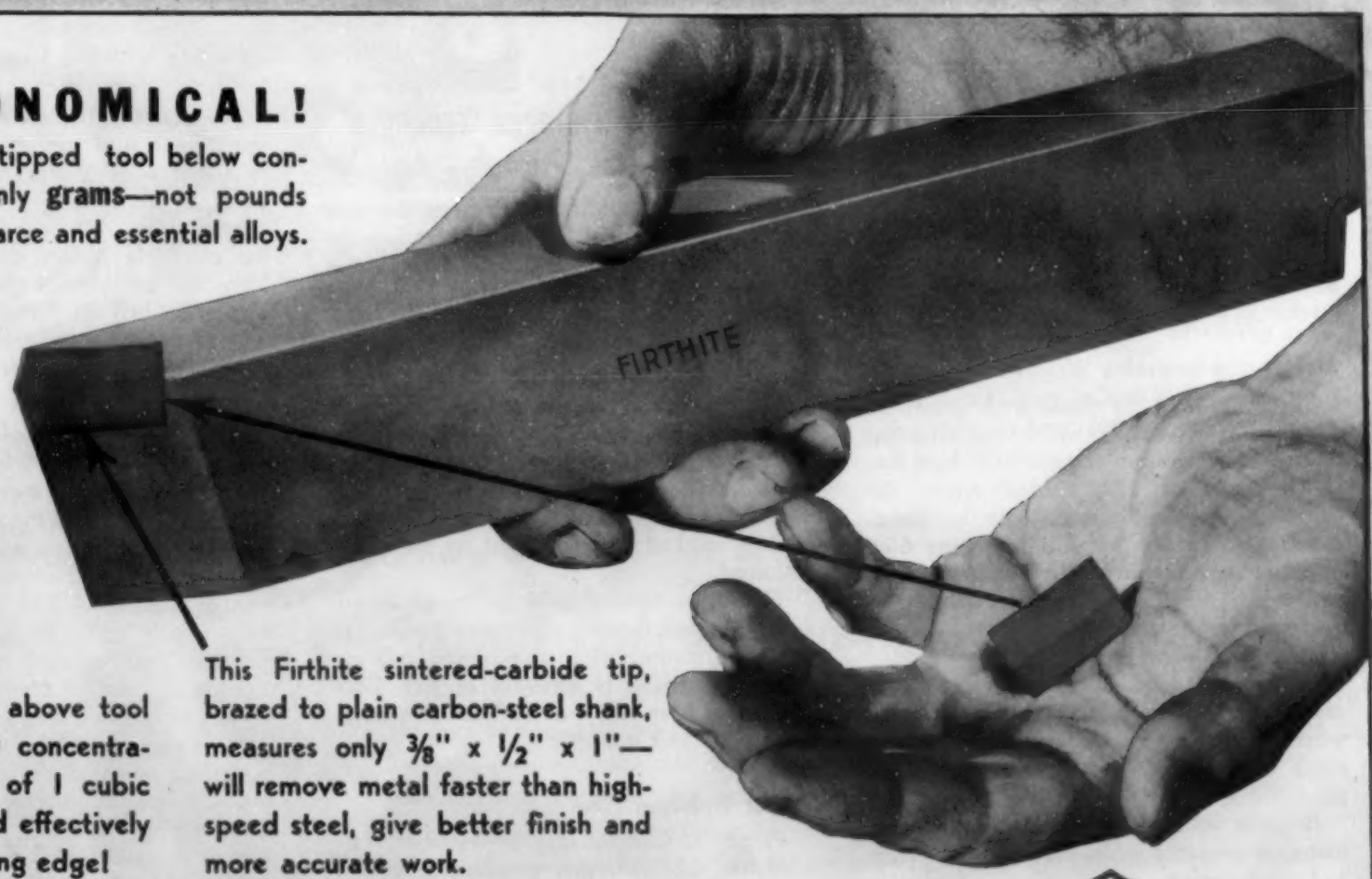
Solid, alloy tool below ties up from one to one and one-half pounds of scarce alloys.

PINK on the above tool shows alloy diffusion through 24 cubic inches. A needless waste!

In the above 2" x 1" x 12" high-speed steel tool, only that part of the alloy at the cutting edge is of immediate usefulness—the balance is lost for present requirements.

ECONOMICAL!

Firthite-tipped tool below contains only **grams**—not pounds —of scarce and essential alloys.



RED on the above tool shows alloy concentration, 3/16 of 1 cubic inch, placed effectively at the cutting edge!

This Firthite sintered-carbide tip, brazed to plain carbon-steel shank, measures only 3/8" x 1/2" x 1"—will remove metal faster than high-speed steel, give better finish and more accurate work.

FIRTHITE

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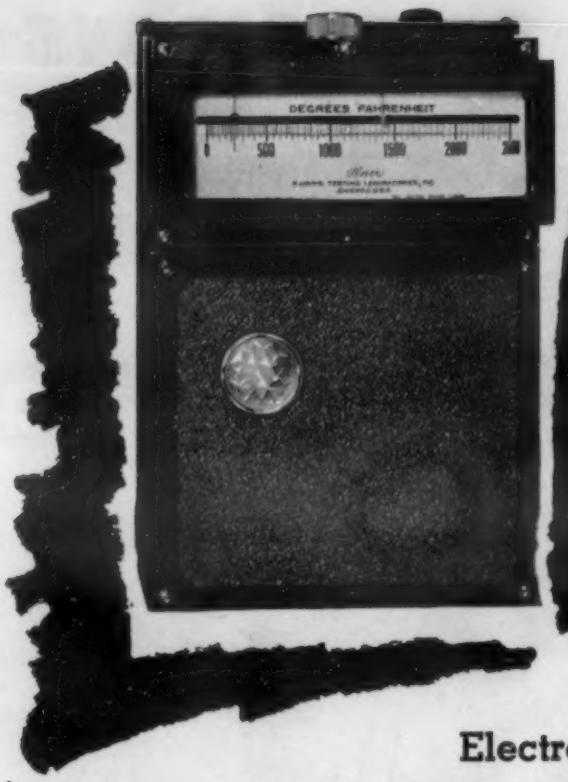

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liquid. Hard-facing then applied will spread thinly in a true tinning style. In other places hard-facing deposits seem to work miracles, particularly on bearing surfaces subjected to great abrasive wear.

Teeth on a broken gear may be welded. Cast iron teeth are usually replaced with bronze. Steel gear may be built up with the torch and a steel rod. Handles broken from machines may be welded back into place.

Making and Improving Wrenches

Wrenches may be made and improved. An open-type wrench which bothered the mechanic by sliding off the nut, had two short pieces of rod welded across the corners. A fine S-wrench may be flame-cut from a spring leaf. After being filed or ground it should be heat treated to reestablish the strength of the steel. A barrel or socket wrench may be made from a motor car wrist pin.

An eye shield of shatter proof glass in a cast frame has been welded to an emery wheel guard. The shield is on a hinge made by welding short pieces of ¼-in. pipe.

Brazing applied with the torch saves many air-operated tools, particularly pistons and connecting rods. Cast aluminum bodies of air-powered tools that have cracked or broken may be welded and replaced. There are also many other applications of welding such as broken castings of all types and kinds and a myriad of parts of all sizes.

—Arthur Havens, *Welding Engineer*, Vol. 27, Nov. 1942, pages 35-37.

Saving Tungsten Electrodes in Atomic Hydrogen Welding

Condensed from "The Welding Engineer"

The present scarcity of tungsten makes it necessary to conserve it by eliminating the careless methods of handling the electrodes of almost pure tungsten which are used in atomic-hydrogen welding.

If a short length of electrode is needed, the standard lengths may be cut in a cutting wheel or on the cover of a grinding wheel but never broken. This is because, if crystalline in structure, the electrode will shatter when broken or, if fibrous, will split longitudinally. Stub ends should always be saved to use when required.

Hydrogen flow should be properly adjusted. Insufficient hydrogen results in excessive consumption of tungsten and excessive hydrogen is wasteful of gas. Both conditions have an adverse effect upon welding speed and quality.

Proper Hydrogen Flow

Proper adjustment may be found by (1) reducing the hydrogen pressure from approximately 10 lbs. per sq. in. until small beads, indicating rapid evaporation, begin to form on the ends of the electrodes and the arc becomes unstable; and (2) increasing the pressure slowly until the beads disappear and a well-defined arc appears. The reducing valve should be kept set at this point, probably between 4 and 7 lbs. per sq. in., and not changed unless the electrode holder or clamps are changed.

Only experience gives knowledge of the proper current and, in welding many of the same pieces, it pays to spend time in determining optimum welding procedure. The size of the electrode should be selected so that the operating current falls within its current range. With a choice between two electrodes, the larger will reduce the possibility of overheating the tungsten near the arcing end and make it easier to establish and maintain a stable arc.

The holder must be adjusted for minimum and maximum extension of the electrode from the clamps. If the maximum is exceeded, there is likelihood of overheating and evaporating the tungsten unless excessive hydrogen is used. The electrode may drop off in globules when the extension is exceptionally long and/or when the electrode is being operated near its maximum current density.

Burning to less than minimum extension causes danger of damaging the clamp tips. Burned tips must be replaced but dirty ones may be cleaned with a wire brush or blunt tool.

Caring for the Electrode Holder

The electrode holder should be hung up when not in use. The collet chuck, the portion of the clamp making contact with the electrode, should be kept clean so as not to restrict the flow of hydrogen. As the electrode is consumed it may be tapped with a wooden or fiber block. Fibrous electrodes often split when tapped with steel. The clamping nuts should be tightened with the fingers. Pliers or other tools cause breakage.

Neither the molten filler nor the work must come into contact with the electrode, as slight adulteration reduces the melting point of pure tungsten and increases its consumption. If it happens by accident, the electrode holder should be moved to force the arc outside the hydrogen shield. The alloy ball on the end of the electrode will be oxidized and the source of contamination eliminated.

Any spatter on the electrodes should be removed with a wire brush or blunt instrument when the arc is stopped.

The work should be arranged, or jigs and fixtures used, so that the percentage of welding time to arc time will be increased, as frequent starts and stops increase consumption of tungsten. The experienced welder will usually start the arc on his first attempt. The beginner may find it advantageous to start by drawing the tips across a piece of charred wood or graphite.

By using a short length of electrode in the top of the clamp for a hydrogen seal and a means of moving the electrode, all electrodes may be economically burned down to ends of one to two inches.

All stub ends should be saved and sold at the current price of tungsten ore. The General Electric Co. will purchase them in minimum quantities of 5 lbs. On a nation-wide scale, such trivial conservation methods will save a large amount of tungsten.

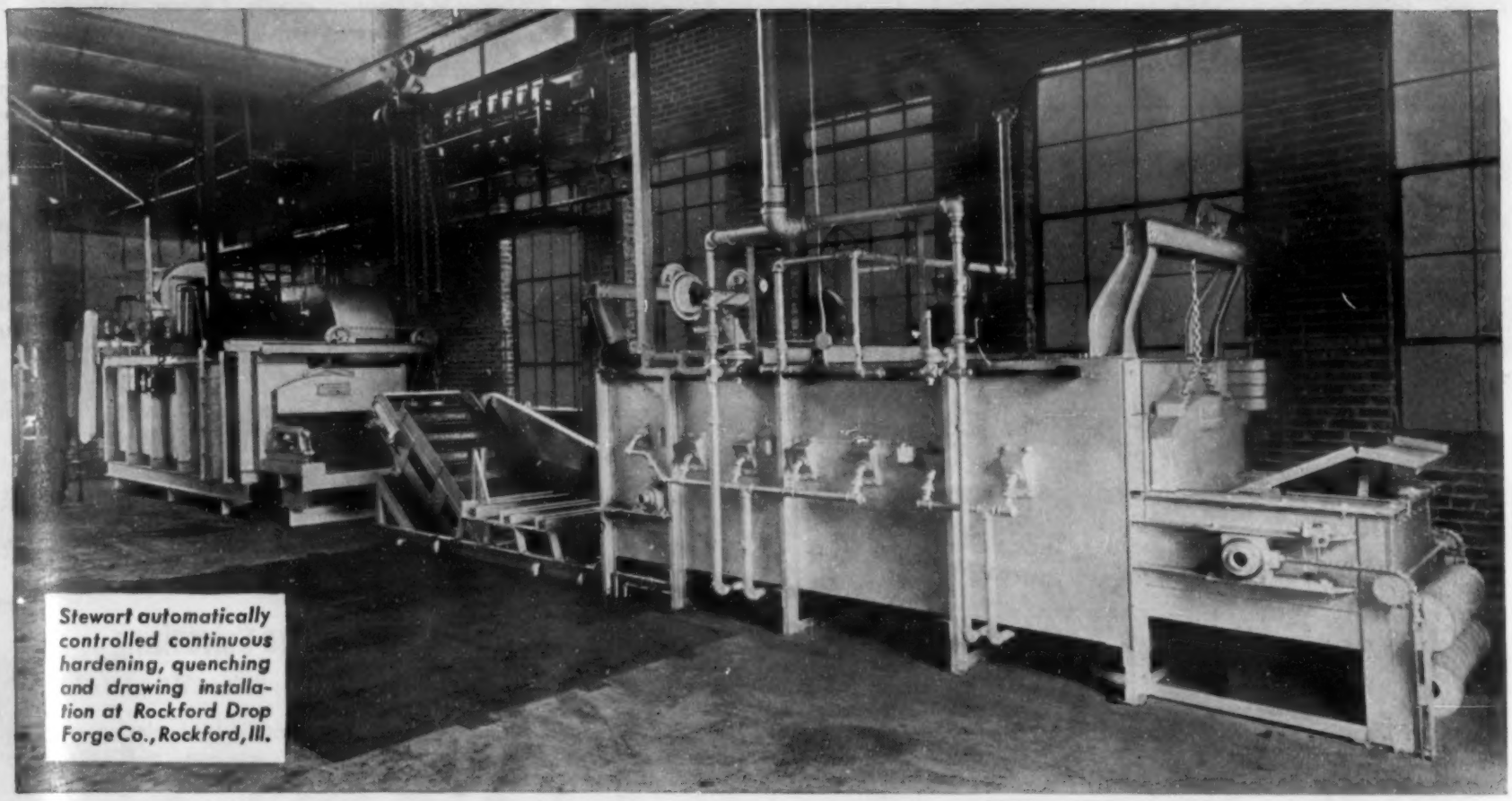
—L. G. Pickhaver, *Welding Engineer*, Vol. 27, Nov. 1942, pages 39-41.

MEETING HEAT-TREATING REQUIREMENTS IN MODERN DROP-FORGE WORK *with*

No. 41 OF A SERIES of Typical Installations

STEWART

THE BEST INDUSTRIAL FURNACES MADE



Stewart automatically controlled continuous hardening, quenching and drawing installation at Rockford Drop Forge Co., Rockford, Ill.

The Rockford Drop Forge Company of Rockford, Illinois, is called upon to fabricate up to 3500 tons of steel per month. All this tonnage requires heating to produce plasticity for forging. After the metal has been formed into the desired shape, it must be submitted to various types of heat treatments to produce the desired physical properties such as normalizing, annealing, heating for quenching, and drawing.

Since the Rockford Drop Forge Company operates a commercial shop, it must obtain heat treatment equipment elastic enough to treat many shapes and parts made of steel of various grades and chemical analyses. To meet production demands, economy and uniform physical properties in such items as automotive connecting rods, etc., a Stewart automatically controlled continuous hardening, quenching and drawing furnace was installed.

Mr. J. N. Harris, Metallurgical Engineer at the Rockford Drop Forge Company, writes us that "the Stewart units are now operating on war production materials and doing a wonderful job for Victory."

This installation is typical of the industrial furnaces Stewart engineers are building every day to meet the specified requirements of manufacturers all over the continent.

Stewart builds, in addition, a full line of standard type furnaces.

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Sixty-eight pages of charts, tables, diagrams and factual data on latest steel specifications, characteristics and applications, heat treatments, heating time allowances, hardness and tempering conversion tables, carburizing, case hardening, cyaniding, quenching notes, furnace capacity information, melting points of common metals, etc. Handy, vest-pocket size. We will be glad to send you a copy with our compliments upon request.

A letter, wire or 'phone call will promptly bring you information and details on STEWART Furnaces, either units for which plans are now ready or units especially designed to meet your need. Or, if you prefer, a STEWART engineer will be glad to call and discuss your heat-treating problems with you.

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New Uses for Induction Heating

Condensed from "American Machinist"

Induction heating has the following advantages: (1) Close control of time and temperature; (2) ability to use on production line; (3) decreased oxidation and distortion.

Before the war, induction heating was used mainly on iron and steel. Such applications are still of importance: *e.g.* heating bar stock for forging shell, hardening armor piercing shell, brazing bomb bodies and aircraft sub-assemblies. However, it is now being used for non-magnetic alloys; *e.g.* for mouth annealing brass cartridge cases, selective annealing of aluminum aircraft sub-assemblies, etc. In the case of steel, the steel should be properly heat treated to the best core structure (usually sorbitic) before induction hardening.

High carbon steel punches for drawing cartridge cases are being hardened by induction to minimize distortion and decrease grinding allowances. Oil hardening steels can be water quenched after induction hardening because of the close control of pressure and time of water quenching.

In the case of internal selective hardening — bores of steel tubes, aircraft engine cylinder barrels, alloy iron Diesel engine sleeves — the time required is even less than in hardening externally because the energy can be much more concentrated. Induction annealing is being used for gun parts of SAE 1050, and for the rim portion of cold drawn 105 mm. steel howitzer cases.

Important savings can be realized in scarce alloys by proper application of induction hardening; *i.e.* SAE 52100 can be satisfactorily replaced by SAE 1055 and 1065. SAE 1040 may prove entirely satisfactory for aircraft engine cylinder barrels, etc. Also, induction hardening of the inside of tubes increases the physical properties, minimizes wear and possibly avoids the need to specify a better material.

Induction hardening acts as a 100 per cent inspection, since it shows up defects which may have escaped detection in prior examination (sand holes, porosity and other heterogeneous parts.)

Although the equipment cost is high, it is often offset by other factors. For example, blanks for 75 mm. shells are heated in induction furnaces one at a time; 2 min. 28 sec. are required to heat to 2350 deg. F. But the soft scale on the billet so heated is responsible for longer die life and less machine down time.

The newest development is probably the production of composite structure through brazing and soldering. The heat is confined to the braze line, so the physical properties of the other portions of the projectile are not affected.

—R. LeGrand, *American Machinist*, Vol. 86, Oct. 1, 1942, pages 1079-1081; Oct. 15, 1942, pages 1158-1161.

Electro-Galvanizing

Condensed from "Sheet Metal Industries"

The general method of electro-galvanizing steel strip was to pull the strip through long baths in which it was plated. This method was cumbersome, expensive, and produced bubbles of hydrogen which detracted from the perfection of the coating. The British Coated Sheets, Ltd. first attacked the problem on the basis of steel sheets. Exposure to the current for a series of short periods gave a finer and more uniform coating than prolonged exposure in one vat. Four main problems had to be solved:

1. Avoidance of bending — solved by having horizontal slits in the vats for entry and egress. The resulting electrolyte leakage was turned into an advantage by using a much larger volume, and circulating it so that the leakage is returned to the storage tank. The greater volume also led to increased stability.

2. Constant progression through the vat or vats.

3. A series of operations rather than one prolonged immersion. Therefore a number of comparatively short but wide vats were used.

4. Elimination of hydrogen was accomplished by having rubber lips on the horizontal orifices, which clean off the bubbles adhering to the sheets as they come from each vat.

Details are given of modifications necessary if strip is to be electrogalvanized.

The steel moves first through a series of 3 or more pickling vats using 6.5 to 13 per cent H_2SO_4 (depending upon the quality of the sheet or strip) at 115 deg.

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The Robinson Method of High-Frequency Induction Heat-Treating completely eliminates inconvenient hardening methods. The heat-treating cycle is reduced to minutes — or seconds.

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Robinson Automatic Units reduce the cost of heat-treating to a fraction of former figures. The short heat-treating cycle eliminates scaling and decarburization — prevents austenitic grain growth. Human error is reduced to a minimum— the number of rejects is further reduced by standardized performance as each heat-treated part is identical to the ones preceding and following.

PRECISE CONTROL OVER THE HEAT-TREATING PROCESS

The location, temperature, time at temperature, and depth of heat penetration are easily and accurately controlled. The core structure of the product to be heat-treated can be retained, if desired, without danger of the case crushing when subjected to severe deformation stresses. Inside surfaces may be locally heat-treated with the same ease as outside surfaces.

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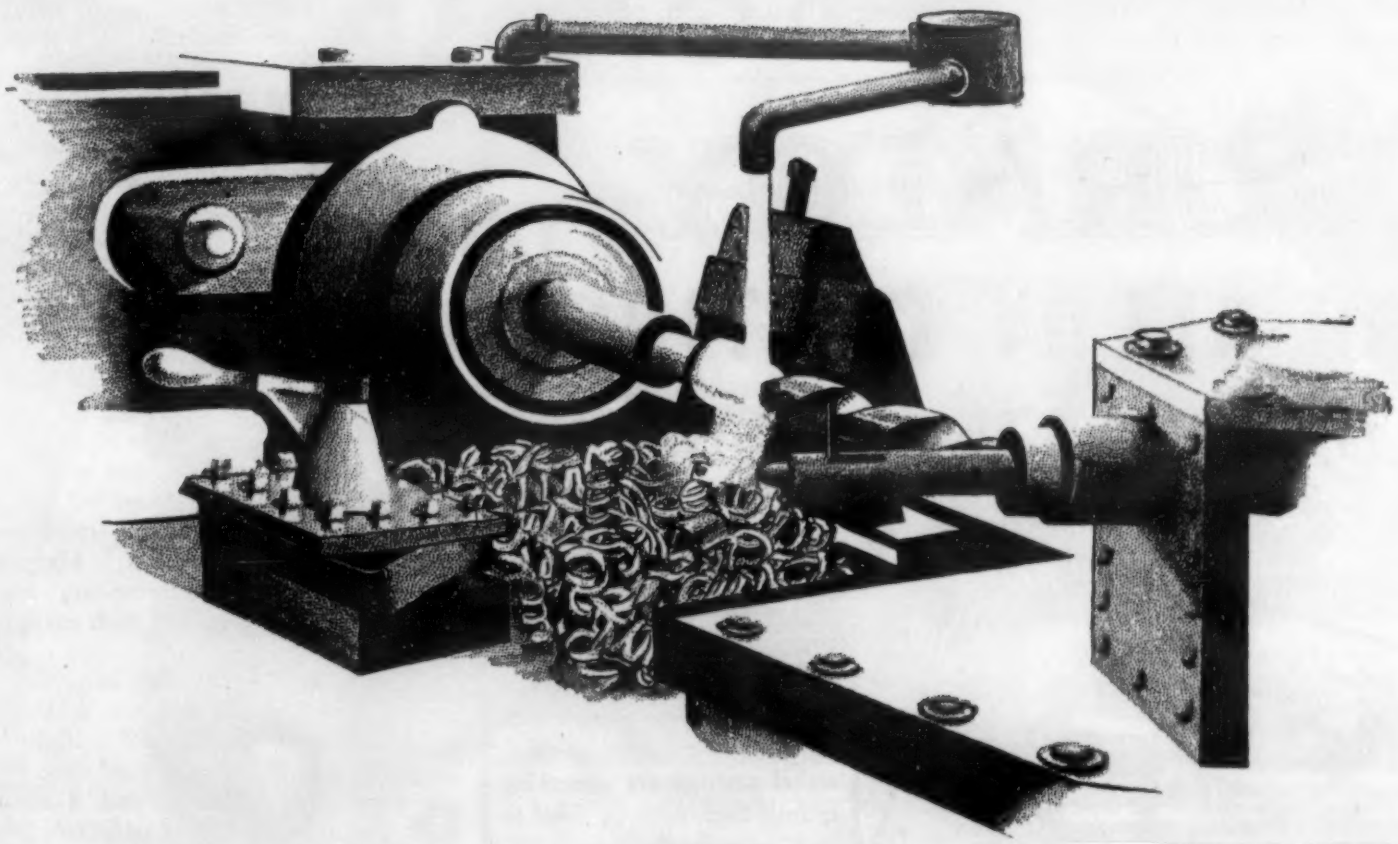
Out of Your CUTTER



. . . Best bet is to check your cutting fluid. For while there are many machining operations, there can be only one *correct* cutting oil for your particular job. That's the coolant that delivers the "tops" in speed, finish, and tool life.

The difference between a "top" lubricant and one of ordinary quality means much these days of high speed, precision production. Particularly because many manufacturers are working many different types of materials, each presenting a new cutting oil problem. Cities Service Chillo Cutting Oils and Cities Service lubrication engineers have solved many of these problems and are continuing to do so daily. Why not find out what this combination will do for you? A consultation will cost you nothing. A copy of a new booklet, on "Metal Cutting Lubrication," will be sent free to users of cutting oils.

Just drop us a line or get in touch with the nearest Cities Service office. There is no obligation, of course!

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F. Between each pickling vat is a pair of rotary scrubbers. If the steel is oxidized badly or has been oil dipped, additional vats may be required. The acidity of the pickle should be checked frequently by a hydrometer and by analysis for iron by the cupferron method. Two hot washing vats with a rotary scrubber are used to remove finally any foreign matter. The brushes are rotated in the same direction as the strip to avoid catching the strip in the brushes.

In the plating bath, the feed rollers form the negative connection. The top roller is of stainless steel and the lower roller of semi-hard rubber presses the steel into perfect contact with the cathode. The steel is passed through a series of plating vats dependent upon the amount of zinc to be deposited and the pace at which it is desired to pass the sheets through.

The plating solution contains aluminum sulphate ($Al_2SO_4.18H_2O$) zinc sulphate ($ZnSO_4.7H_2O$) sulphuric acid (H_2SO_4) and two unnamed colloids. Methods are given for checking the composition of the bath. The temperature is 95 to 115 deg. F. After the solution reaches 115 deg. F., the heating is turned off as the heat from the adjacent pickle and the heat caused by the current will keep the temperature within the range for a complete 8-hr. shift. Excess electrolyte is removed by a wash in warm water (135 deg. F.).

The steel is then dried in a drying chamber at 130 deg. F.; 99 per cent pure zinc with an area of 36 sq. ft. is used for anodes. Approximate recovery is about 24 per cent of the original weight. Anodes are not allowed to become too thin as a higher voltage would then have to be used.

A current density of 100 amps. per sq. ft. of surface is utilized. In the particular machine described, 22 BG strip, 1¼ in. wide, can be plated with 0.045 to 0.05 oz. per sq. ft. of surface with a weekly output of approximately 100 tons (24 hr.-7 day week) as 24 strips are put through concurrently.

—G. G. J. Adey, *Sheet Metal Ind.*, Vol. 16, Sept. 1942, pages 1309-1314.

Contour Metal Sawing

Condensed from "Heat Treating and Forging"

Tests with four leading brands of metal-cutting band-saws showed a variation of cutting time on a fixed linear dimension and a variation in wear of teeth. Investigation of individual milling and setting of teeth indicated all four brands were equal, previous to testing.

Test was made with ¼-in. 12 P-Raker tooth heavy set-A temper saw bands. X-ray examination showed all four welded bands were entirely free from cracks and other hardening defects. Material sawed was 1½-in. high-chromium, high-carbon steel. Sawing period with each band was 30 min.

Saw No. 1 cut 7½ in.; No. 2 cut 7 in; No. 3, 6 in.; and No. 4, 5½ in. Magnification at X40 showed a slight but identical wear of teeth with Nos. 1 and 2 saws. Saws Nos. 3 and 4 also showed identical wear but considerably more than the first two.

A second 30-min. test was made with Nos. 1 and 2 saws. In this test, No. 1 saw again cut 7½ in., while No. 2 dropped to 6½ in. A second examination of the teeth showed that saw No. 2 had worn slightly more than No. 1.

Inquiries from the respective manufacturers of these two bands revealed that ultimate tensile strength of saw No. 1 was 132,680 lbs. per sq. in., whereas that of No. 2 was 90,730 lbs. per sq. in. Superiority of saw No. 1 was attributed to an improved air-gas furnace hardening technique and annealing at 350 deg. F. had an ultimate strength of 115,120 lbs. per sq. in. Another band similarly hardened but annealed at 490 deg. F. had an ultimate strength of 109,268 lbs. per sq. in.

It is therefore apparent that tensile strength is a governing factor of band-saw life, and that heat treatment must be precisely controlled.

Saw No. 1 was almost entirely free from camber. This feature of accuracy has much to do to preserve uniform cutting action. All band-saw stock is subject to camber from the mill through processing. The milling operation relieves some of the strains on one side of the band, but only by exact control of the heat-treating process can stresses be adjusted so as to produce bands of maximum straightness.

— H. J. Chamberland, *Heat Treating & Forging*, Vol. 28, Nov. 1942, pages 589-590.

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We take pride in our work. Our twenty years of service to industry in connection with chrome-iron and chrome-nickel castings are something to look back upon . . . and to build upon for the future. We make the best high alloy castings it is possible to make.

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Hardening of Engine Cylinder Sleeves in Internally Heated Nu-Sal Bath.

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Resistance Welding Electrodes

Condensed from "Sheet Metal Industries"

It is of fundamental importance in spot welding that the electrode tips maintain their shape and size as modifications in tip diameter change current density and therefore the heating in a given time.

Ordinary copper leaves much to be desired because of its softness and early deformation entailing considerable maintenance work. Various other combinations such as copper-cadmium, copper-chromium, copper-chromium-cobalt, copper-beryllium, copper-silver, and copper-cadmium-silver have been tried in efforts to increase the hardness at high temperatures without decreasing unduly the electrical and thermal conductivity. For example at 300 deg. C. (572 deg. F.) where the hardness of copper is about 50 Brinell, copper-cadmium-silver (largely used for resistance welding electrodes) is about 140, copper-cadmium (cold worked) 125, and copper-chromium (heat treated and cold worked) 150.

The minimum amount of these special materials should be used since conductivity is never as high and cost is always much greater than copper. If the dimensions of the electrode are large (1¼ to 1½ in. diam.), driven inserts may be used. Another modification (Komovski electrode) uses a steel or strong copper base alloy ring around the tip to obviate spreading or mushrooming.

In very few cases is it possible to use a composite metal such as copper-tungsten or silver-tungsten as it invariably tends to stick to the stock during welding. However, considerable success has been obtained with driven inserts of this type in copper or copper-cadmium electrode shanks for welding nickel, tungsten, and molybdenum.

In the case of seam welder electrodes, it is most economical to use rings as the renewable electrodes rather than discs. These rings are usually clamped or screwed onto the normal copper or copper alloy disc body.

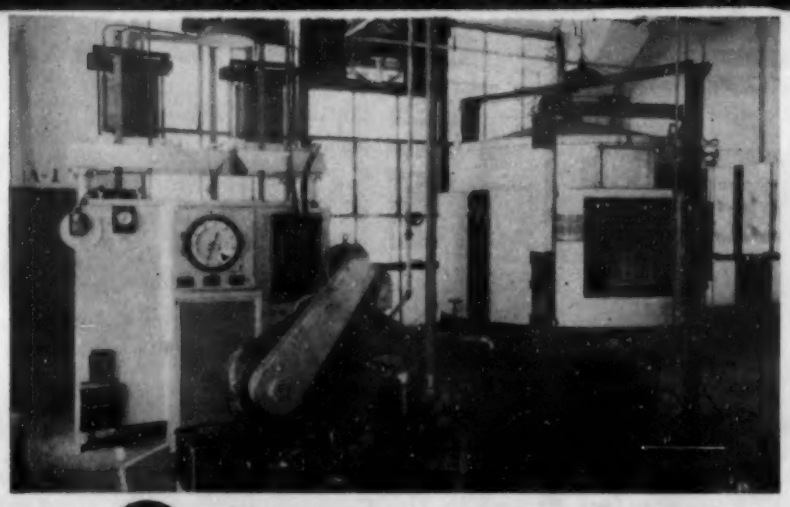
In flash welder jaws, the usual aluminum bronze or copper base alloy dies can be used to advantage by the addition of facings or edgings or inserts of copper-tungsten composite metal sections which are usually produced by powder metallurgy. Since these jaws clamp the parts and merely convey current to the parts to be welded but not to the actual weld location, they are relatively cold and greater hardness even at the expense of conductivity is desirable.

In projection welding, inserts of composite copper tungsten of great hardness and high conductivity can be used to advantage.

—S. H. Parsonage, *Sheet Metal Ind.* Vol. 16, Dec. 1942, pages 1913-1916.

EF FURNACES

For Every Industrial Heat Treating Process



THIS SMALL EF SPECIAL ATMOSPHERE FURNACE

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While more widely known as "designers and builders of large production furnaces," The Electric Furnace Company also builds numerous smaller continuous automatic units. These smaller furnaces incorporate the same expert engineering service and experience and the same ruggedness and refinements which characterize their larger units.

The above rotary, scale-free hardening furnace is an excellent example. This comparatively small and inexpensive installation handles miscellaneous small and medium sized products such as springs, bolts, screws, etc., at the rate of 250 lbs. per hour.

The complete unit consists of furnace, quenching equipment, automatic controls and an Elfurno generator for supplying the protective atmosphere for scale-free hardening.

With this equipment, the heat treating of miscellaneous small and medium sized parts and products is placed on a practical, continuous, uniform and economical basis. The furnace has two doors and two quench tanks. The material is loaded into heat resisting alloy trays, carried around the furnace and discharged through sealed chutes to either a water or an oil quench. The drive is so arranged that the rotation of the hearth may be in either direction, thus by using opposite doors for loading, it is possible to operate the furnace in either direction and to discharge into either the oil or the water quench.

This permits considerable flexibility as the material may be either oil or water quenched from the same equipment without moving the quench tanks or changing the quenching medium. By removing the material from the trays instead of discharging into quench tanks, this furnace can also be used for drawing, annealing or other processes.

For heat treating from 300 to 1700 lbs. per hour, we recommend the EF Continuous Chain Belt Conveyor Type Furnaces which we build in five standard sizes. These furnaces handle all kinds of products ranging in size from small springs and machine gun cartridge clips up to large track links for tanks and tractors. Send for additional information on the above and other types.

The Electric Furnace Co., Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces---For Any Process, Product or Production

New Lead Plating Process

Condensed from Proceedings of the American Electroplaters' Society

Ease of preparation and stability are advantages stated for the lead sulfamate plating bath. Another advantage is freedom from the hazards attendant on the use of hydrofluoric acid, which is required in operating either the fluoborate or fluosilicate lead plating baths. A preferred bath composition is: Lead plating salts, 40 oz. per gal.; addition agent No. 1, 1.3 oz. per gal.; addition agent No. 2, 0.04 oz. per gal. In many applications only addition agent No. 1 is required.

For barrel plating, or in cases where unusually good covering power is required, addition agent No. 2 is used. The presence of suspended matter in the bath appears to have little effect upon the smoothness of the deposit.

Operating characteristics are: Anode and cathode current efficiencies, 100 per cent; cathode current density, 5 to 40 amp. per sq. ft.; anode current density, 5 to 150 amp. per sq. ft.; pH, 1.3 to 2.0; temp., 75 to 120 deg. F.; voltage (still), 3 to 8, (barrel), 9 to 14; throwing power (Haring Cell, 5 to 1 ratio), about 0 per cent; deposition rate, 0.001 in. in 21 mins. at 20 amp. per sq. ft.

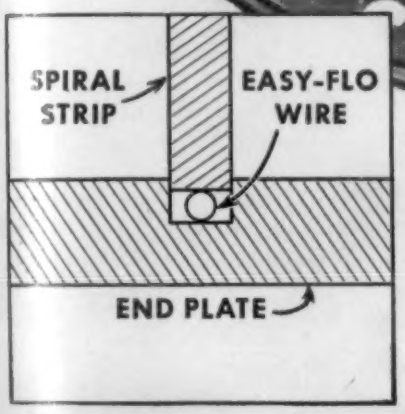
Lead plated directly on steel adheres fairly well but, for best adhesion, a copper cyanide strike is recommended.

Suggested commercial applications of lead plating include the plating of nuts, bolts, etc., to replace strategic metals such as copper, cadmium, and nickel. Other uses are the plating of wire as a drawing lubricant, and the plating of structural steel for corrosion resistance.

—E. W. Schweikher, *Proc. Am. Electroplaters' Soc.*, 1942, pages 90-91.

Change to EASY-FLO brazed construction *jumped production over 500%*

on this war job



Assemblies are prepared with 1/32" dia. EASY-FLO wire preplaced in a groove. Spiral strip is weighted on top to force it down when EASY-FLO melts. Assemblies are brazed in a gas furnace. Preplacing the alloy helps speed production and gives control of amount of alloy used.

THE JOB—Producing aircraft machine gun magazine end plates.

FORMER METHOD—Plates were machined from heavy forgings. Production rate was 32 minutes per plate.

NOW—Spiral strips are EASY-FLO brazed to steel stampings as shown in the illustrations.

RESULTS—EASY-FLO brazed construction changed this job from a bottleneck to the fastest operation on the line. It reduced time per plate to 5 minutes, a production jump of over 500%—saved thousands of lbs. of steel and hundreds of man-hours—freed machines for other work—cut costs to such an extent that substantially lower bids were made on subsequent contracts. In a part going into planes, the weight reduction was particularly advantageous.

EASY-FLO IS THE KEY

Equally gratifying results have been obtained on many other war jobs redesigned for EASY-FLO brazed construction—a construction made practical because this low-temperature silver alloy makes joints as strong as solid metal—and makes them fast and reliably because it is so free-flowing, fast-acting.

IT IS EASY TO CHANGE TO EASY-FLO BRAZED CONSTRUCTION

This fact plus the benefits gained in time, metal saved and savings in cost, justifies a change from machined parts to EASY-FLO brazed construction wherever possible. We'll be glad to cooperate in checking your designs for opportunities.

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speed, reliability and economy on both ferrous and non-ferrous metal joining, write today for Bulletin 12.

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4 Materials and Engineering Design

Engineering Properties of Metals and Alloys • Resistance to Corrosion, Wear, Fatigue, Creep, etc. • Engineering Design Problems of Specific Industries and Products • Selection of Metals, Metal-Forms and Fabricating Methods • Non-Metallics in the Metal Industries • Applications of Individual Materials • Conservation and Substitution

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Metals in a German Aero Engine

Condensed from "S.A.E. Journal"

The Junkers 211 B engine is one of 3 large liquid-cooled aircraft engines known to be produced in quantity in Germany. It powers the Junkers JU-88 and Heinkle He 111K twin-engine dive bomber, and the Focke-Wulf FW 200 K long range 4-engine bomber.

The engine examined has apparently run but a few hours since being overhauled. Its cylinder block was poured in October 1939 but examination of an engine with a more recently poured crankcase showed no observable changes.

General Appraisal

Like the Daimler-Benz 601 series, it has a 60-deg. inverted-vee with direct gasoline injection, but its fundamental construction, detail design practice, and metallurgy are surprisingly different. The only parts in common are possibly the starter and generator.

The general arrangement is logical and simple but the solution of typical design problems for optimum stress distribution is carried to the most minute details. Parts expected to require service replacement appear to be interchangeable. Surface finish and dimensional uniformity of like parts equal American practice, with but few exceptions.

Materials betrayed little shortage of strategic alloying elements. In general, the steels were drawn to hardness far below their usable upper limits and control of grain size was somewhat neglected.

Specifications follow the usual German practice of very large displacements and conservative mean effective pressures and rotative speeds. However, the relatively light weight per unit of displacement results in a net power output per pound not far below its competitors.

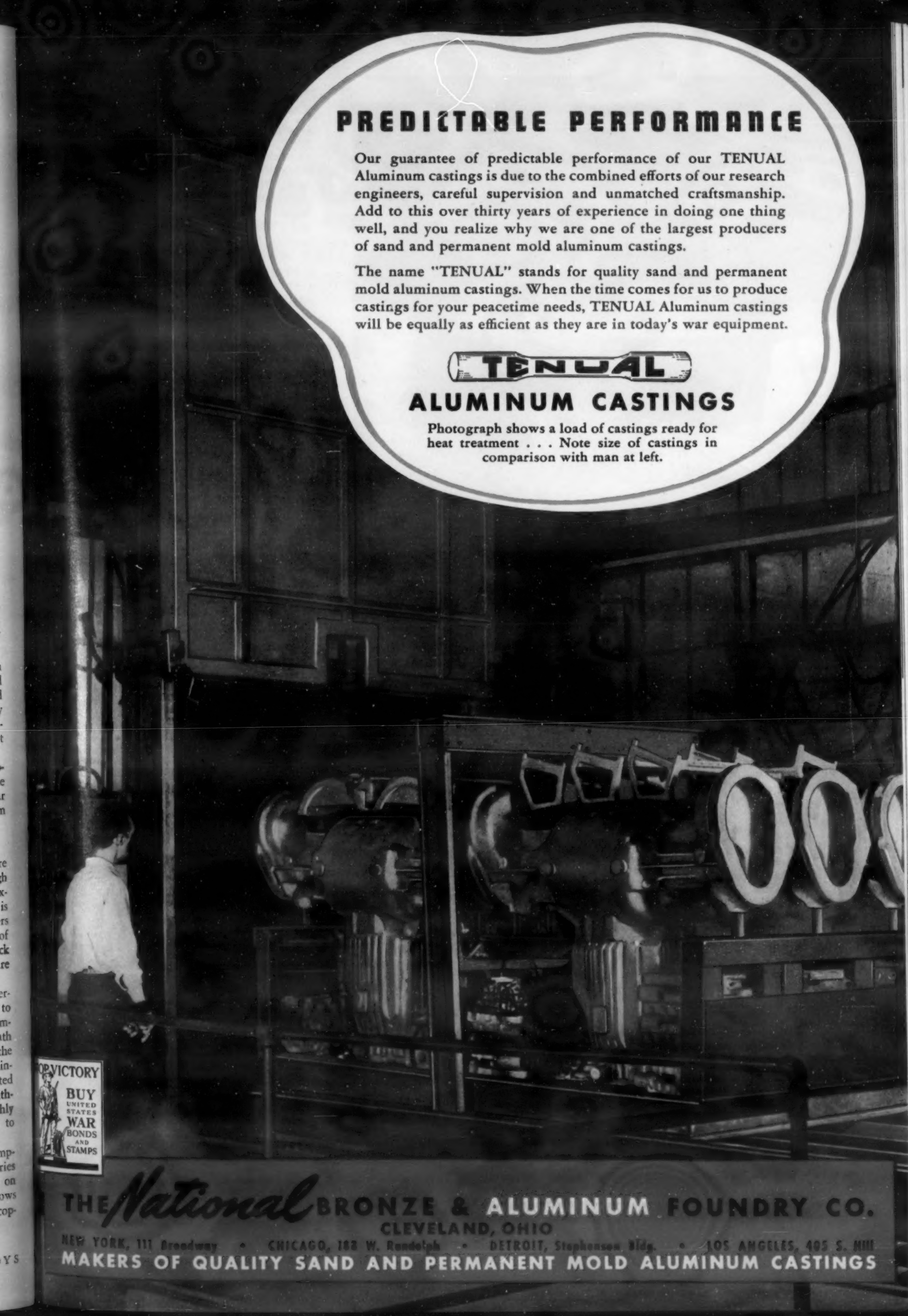
Fully automatic devices controlling propeller speed, manifold pressure, mixture ratio, spark advance, and supercharger gear ratio remove all possible distractions from the pilot.

Constructional Details

Notable in the general arrangement are the compact accessories section, the high mounting location, and the amount of external plumbing. Lengthwise the engine is compact, having 6.62 in. cylinder centers with a 5.9 in. bore. The crankcase is of cast aluminum of substantial monoblock construction. Only the stressed ribs are hand polished.

The angular distribution of counterweights, in the crankshaft, is optimum to relieve main bearing loads. Large compound re-entrant fillets on the underneath semicircumference of crankpins, and the semicircumference of main journals adjoining the working part of the associated crankcheeks, obtain a maximum fillet without reduction of bearing area in the highly loaded portions. Lubricant is supplied to the front of the crankshaft.

No crankshaft torsional vibration dampers are used and splines on the accessories driveshaft were badly galled. Wear on the crankpins in the planes of the throws was high, explainable in part by the copper-lead bearing materials.



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TENUAL

ALUMINUM CASTINGS

Photograph shows a load of castings ready for heat treatment . . . Note size of castings in comparison with man at left.

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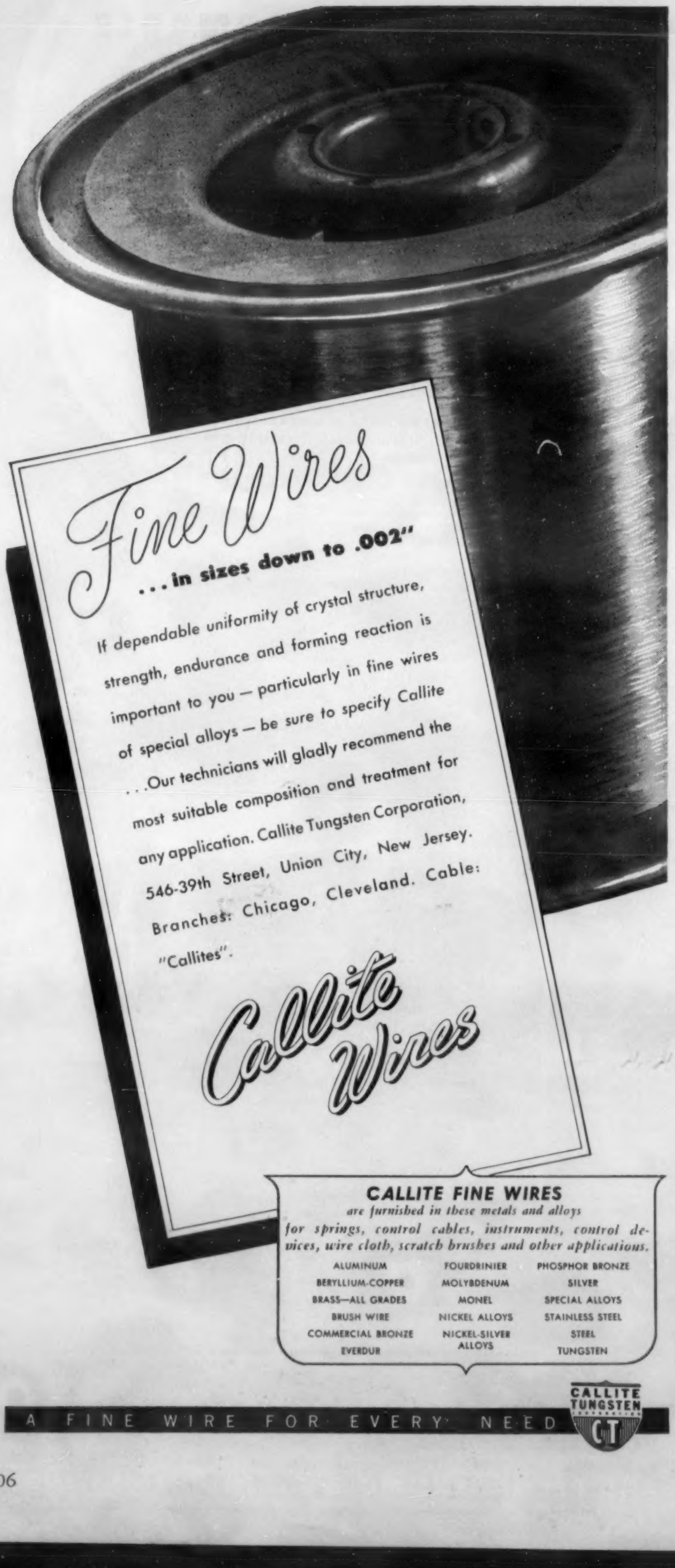
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CT

At the pin-ends of the connecting rods a floating cast iron bushing, lubricated through the top of the eye, adds weight with an unknown motive. The clamped surfaces of the forked rod on the bearing, lubricated by oil from the bearing were badly fretted.

Of interest is the rod bolt locating slot in the outside, unstressed edge; the extreme closeness of the bolt holes to the bearing bore; and the excellent blending of all radii on the forked rod. Connecting-rod and main bearings are of 80-20 copper-lead, backed by very soft steel. Lead dispersion at the bond was good; imperfect in the remainder.

The coolant is in direct contact with the exhaust-valve guide and the nozzle holder. The cylinder barrel, of only 245 Brinell hardness, is honed and coated outside with a phenolic resin. Lead attack was present on the inside.

Metal-Design

The exhaust valve, of an alloy corresponding to the usual austenitic valve steel, is faced with an alloy approximating Stellite No. 6 with iron dilution. The intake valve is a 14 per cent Cr martensitic alloy. Valve guides are bronze. Valve port and open areas appear out of proportion, but all rubbing surfaces were in good condition.

The camshaft, supported by seven large bearings of aluminum-iron alloy, is constructed of material equivalent to S.A.E. X 4340. A double spring assembly, the springs of straight helical design, is used on each valve. Spring retainer locks consist of a one piece retainer of soft steel.

The pistons are of forged aluminum alloy employing 3 compression and 2 oil scraper rings. The insides of the pistons are sand-blasted. The skirts are cam ground, quite free from scuffing.

The two-speed supercharger drive has a multiple-disc clutch with free-wheeling cam and slipper clutch. The fully shrouded impeller is a magnesium alloy forging, machined all over. Aluminum entrance vanes are used, but no diffuser.

The splines, of the involute type, are designed to do only the driving, not centering. A notable feature of the main reduction gear is the high polish in the radii at the roots of the teeth. The accessory tower, of cast aluminum, is attached to the rear of the crankcase.

The oil pressure pump, of steel gears in a magnesium housing, has a full capacity of 12 g.p.m. at 45 lbs. per sq. in. pressure. It is attached directly to the strainer housing.

Two unique features in sealing practice are that there are few metal to metal sealing surfaces, paper, synthetic rubber gaskets and seals being used extensively; and that synthetic rubber gaskets mounted in grooves are used in great numbers.

Contrary to former reports of German designs, microcomparator photographs indicate that the threads are ground. A good degree of uniformity of pitch, pitch diameter, flank angle and root radius is maintained.

Analysis of materials showed no new metallurgical art. Lavish use of alloying elements in the steels and wide variation of chemistry in parts requiring similar

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PURDY *War steels* PLUS *Know how*

THE "DUMB" PASSENGER

The crack express was already pounding its way west when the reporters decided to call it a night. Tomorrow's job—a feature story on a war industry—meant miles of walking, and they knew it. "Looks like a swell story", said the one, and the other yawningly agreed. "We'd better turn in", he added.

* * *

Up forward, bound for the same destination and restless with the sway of the baggage car, lay another passenger —a mute, inert bundle of steel. Could it have spoken, it might have pointed up their story.

Six hours ago, it had lain in a freight car, buried under 15 tons of its kind. Ordered while enroute to a warehouse, it had been released by an emergency call when still in the car. Warehousemen had unloaded the entire car to reach it, had raced to get it to the station, had placed it aboard the express while even the conductor's watch frowned. Tomorrow this bundle of steel would meet its destiny—on a production line dedicated to freedom.

Hardly a headline story, this, but the final story of America's war production will be a total of thousands like it.

For behind America's might is a host of such small, *extra* efforts. The common denominator of our production victory...will be that extra heave on a wrench, that extra swing of a hammer, *that extra try*...that wins.

Frasse

Mechanical and Aircraft STEELS

Peter A. Frasse and Co., Inc., New York, Philadelphia, Buffalo, Jersey City, Hartford, Rochester, Syracuse

properties, are apparent. The cleanliness of the steel is exceptional. Carburizing is good as to depth but an excess of massive carbides is evident.

A substantial amount of magnesium is found. Most of the aluminum alloys have high silicon content. The 0.63 per cent Co in the cylinder head is notable since it is not present in the other presumably lower stressed, aluminum castings.

Other Engineering Features

It is estimated that the Junkers 211 B engine delivered approximately 1100 b.h.p., giving it a specific weight at take-off of 1.37 lbs. per b.h.p., a mediocre value. To increase the output through higher mean effective pressures would involve changes of such inconvenience that they were probably not seriously considered.

The injection pump is operated at full capacity, while augmenting the fuel rate would require spreading plunger centers. The supercharger is already operated beyond efficient tip speeds for its type. The valve and spark plugs approach their m.e.p. limit.

Wall thicknesses of the cylinder head are light in section, limited by cylinder center distances. Finally, 92 octane gasoline, the apparent German available grade, is probably approached by the present rating, estimated at 210 to 215 lbs. per sq. in., i.m.e.p.

Greater rotative speed is the evident development for this engine but its 6½ in. stroke may impose a few problems.

—Sidney Oldberg and Thomas M. Ball, *S.A.E. Journal*, Vol. 50, Nov. 1942, pp. 465-483.

Applications of Magnet Alloys

Condensed from "General Electric Review"

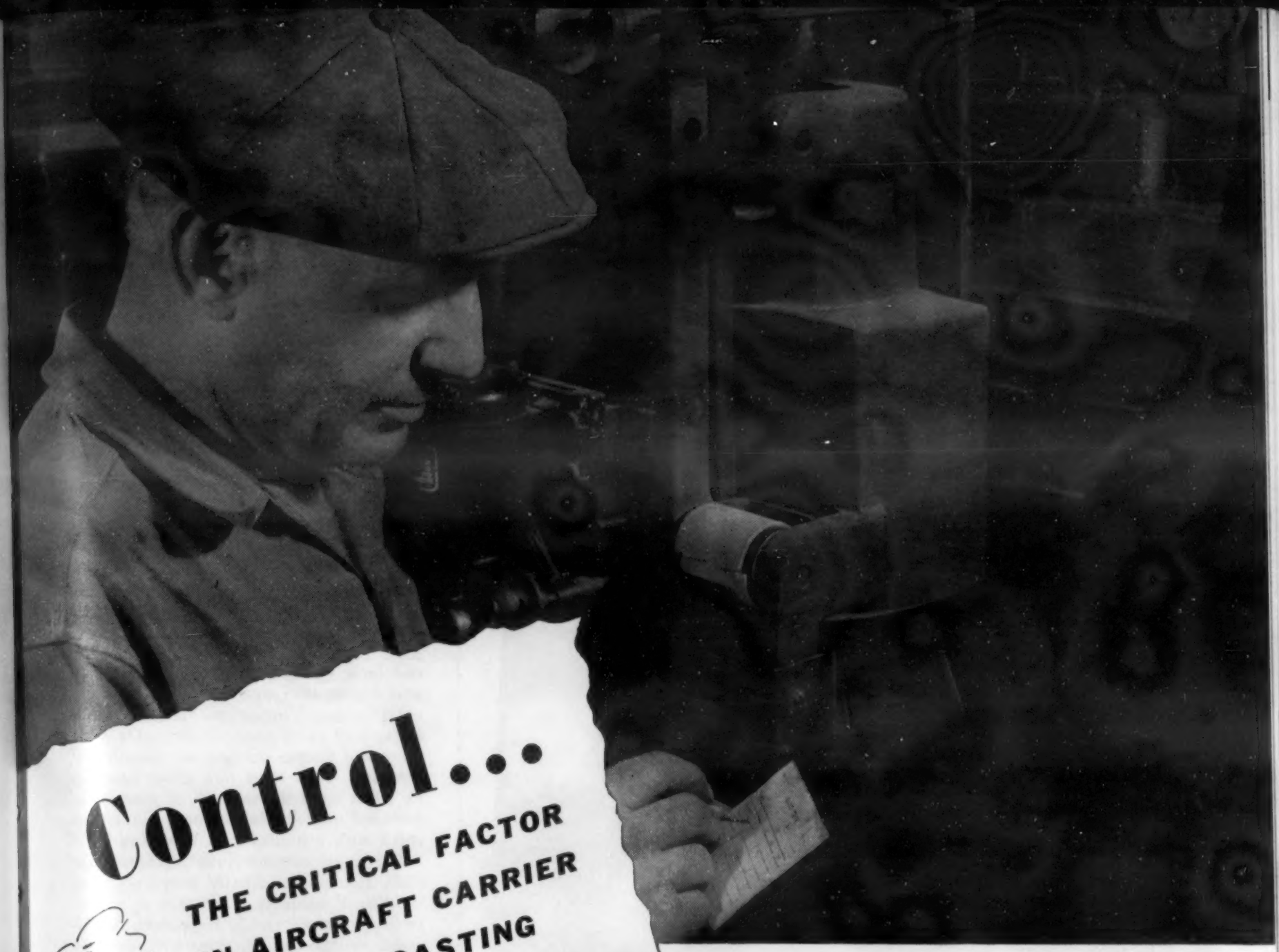
Developments in magnetic materials, particularly the nickel-iron alloys such as permalloy, mumetal, and nicaloi for a.c. applications, and the aluminum-nickel-iron alloys for d.c., have led to improved instruments and instrument performance.

The nickel-iron alloys are characterized by extremely low hysteresis losses and extremely high initial permeability. The reduction in hysteresis losses improves the performance of moving-iron instruments designed for general purpose applications involving the use of the instrument on both alternating current of distorted wave form and on d.c. circuits.

In the Thomson inclined-coil mechanism for voltmeters and ammeters, permalloy has been substituted in the moving element for silicon steel. The gain has placed the instrument in the same accuracy classification as those of the electrodynamic type, bearing in mind that the shielded electrodynamic element will also show small errors due to the shielding.

An a.c. wattmeter, with an air gap of sufficient angular length to permit a usable scale of 240 angular degrees, has a nicaloi core electromagnet. Readily accomplished compensation for low power factor errors and careful design of the electromagnets, result in an instrument of about twice the conventional scale length, which fully meets accepted standards of performance.

The aluminum-nickel-iron alloys for d.c. instruments have a very high instead of a low coercive force, combined with a



Control...

THE CRITICAL FACTOR IN AIRCRAFT CARRIER OR STEEL CASTING

THE aircraft carrier is one of the newer weapons of war . . . a floating "airfield" which can move up the enemy's position . . . strike . . . and withdraw to strike again. Yet . . . for its navigation . . . for the launching and operation of its planes . . . this new naval weapon relies upon a military principle that pre-dates battles as ancient as Thermopylae and Cannae . . . the principle of *control* as the critical factor.

The mechanization of war made control more dominant . . . and today it dominates production line as well as battle line. The Lebanon Steel Foundry . . . producer of castings for America's armed forces . . . guards every possible production step with human, physical and chemical control. The photograph illustrates a Lebanon control operation of first importance . . . the testing of sand in the sand laboratory.

Lebanon selects sands to fit the characteristics of castings. Moisture is closely controlled. When mixed with binder, each batch is developed to correct strength and permeability.

An uncompromising control system is the premium that must be paid to produce castings of Circle (L) quality and integrity. Lebanon pays it proudly. For Circle (L) Castings are the choice of industrial organizations with discriminating standards—such organizations as Mack Truck and American Type Founders.

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suitable value of residual induction, for a maximum available energy.

Chromium and tungsten steels are characterized by coercive forces in the order of 60 or 70 oersteds, a residual induction of about 9000 gausses, and a maximum external energy value of about 0.3×10^6. Alnico II, typical of the newer materials, has values of 520 and 540 oersteds, 6900 and 7200 gausses, and 1.4×10^6 and 1.6×10^6 for maximum external energy for the sintered and cast materials respectively.

The former materials necessitated long U-shaped magnet sections, or magnets in the shape of a horseshoe. With the latter materials, engineers have developed "concentric-magnet instruments," which have elements in concentric shape. This is illustrated by a d.c. voltmeter.

The air-gap flux density of these is about 66 per cent greater than that of the former design. It represents a corresponding increase in available instrument torque per unit of energy input to the moving system. The new systems are self-shielded and the magnets highly resistant to demagnitization. This instrument is one of the conventional 90-deg. angular scale type.

A d.c. ammeter illustrates the application of aluminum-nickel alloys to instruments of the long-scale type. It is similar in general outline to the a.c. wattmeter element. Again an angular air gap of sufficient length for a usable scale arc of 240 angular degrees is obtained, with an increase of 2 to 1 in the scale length.

All of these materials, together with the newer special-purpose, permanent-magnet alloys, such as sintered oxide and silver alloys, are subject to an exacting technique in manufacture and application. The geometry of the magnetic circuit must be suited to the demagnetizing curve of the material involved. The older U shaped magnetic design had an efficiency of roughly 30 per cent and the concentric magnet design has one of about 50.

—A. J. Corson, *General Electric Review*, Vol. 45, Oct. 1942, pp. 573-575.

Substitutes for Gear Steels

Condensed from "Machine Design"

The problem confronting the gear metallurgist and engineer is one of using available materials and specifying a proper heat treatment to provide adequate physicals. The alloys now available, with few exceptions in the armed services, are the National Emergency or "NE" steels. Most of them contain low amounts of chromium and nickel, with molybdenum and manganese higher than usual.

Of primary importance is the tensile strength of steels upon which profile durability and fatigue strength are directly dependent. Tests show that alloys have little effect upon the strength of gear steels, provided appropriate hardness can be secured with a normal heat treatment.

For small sections fully hardened, the yield strength is directly proportional to the Brinell hardness. The ratio is not affected by the alloys. In large sizes, considerable variation exists, dependent upon the alloy content in relation to the heat treatment and greatly influenced by the quality of the steel, test speeds, test bar finish, and associated variables. For larger sizes, the alloys produce a higher yield for a given hardness.

The same relationship expressed for bars and forgings holds true for steel castings. Gears have been placed in service having 1 to 1.15 per cent Mn with molybdenum as low as 0.07 per cent, secured as a residual. Except for the lower hardenability, expected with reduced alloying and compensated for in heat treatment, no difference in the tensile strength-Brinell hardness ratio was noted.

The relation of fatigue to tensile strength has been found to be directly proportional to the ultimate strength and independent of the alloys. The effects of internal stress, sharp notches, cleanliness, surrounding media, etc. have more influence than any effect of alloys.

Toughness of steel may be measured by the per cent elongation and reduction in area of the tensile test but for gear steels the Izod or Charpy impact test is better, since a measure of "notch sensitivity" is also provided. Data on production tests show that hardness or tensile strength (500 x BHN) is a governing factor when definite differences in toughness are desired.

Wear for a given hardness is dependent upon the metallographic constituents and the alloy content. For a given hardness a material rich in carbide formers will show greater wear resistance than one low in these elements.

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When a mask was used only as a guise for lurking danger.

☆

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The mask is used to protect from danger.

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With gears heat treated after cutting, the engineer must compensate his calculated ratings for the lesser accuracy. Final grinding after cutting can partially rectify heat-treating distortions, although other difficulties prevent full utilization of the high accuracy secured on gears cut before heat treatment.

Such distortion is directly a function of the severity of the quench necessary to produce proper hardness. NE steels cannot be expected to perform as satisfactorily from the distortion viewpoint, when present gear-treating equipment is unchanged. Developments in apparatus have alleviated many of the difficulties.

Design Minimizes Distortion

In using NE steels, sections must be more uniform and unsupported rims connected to webs must be increased both at the rim and the web to prevent "bowing" or a bell-shaped contour after quenching.

NE steels are suitable for direct quench and will be required in lieu of double quenching where preference for minimum distortion outweighs core toughness. When production operations prevent a direct quench and maximum core toughness is required, the reheat quench temperature must be carefully investigated. An extremely high core toughness is not a primary requisite for gears and, except for a few applications, pot or direct quenching is suitable for industrial carburized gears.

A manganese-molybdenum steel similar to NE 8020, but of lower manganese, has shown good results as to distortion and service. Internal stress is proportional to the severity of the quench and the degree of internal stress relief obtained in the tempering operation. The amount and balance of alloys plays an important part. A source of trouble will be to extend the range of the lower hardening alloys by drastic quenches without properly tempering to relieve the internal stresses and obtain a stabilized metallographic structure.

Hardenability

Ultimate hardness or tensile strength controls the engineering properties of gear steels, and research shows that the hardness obtained at any point is proportional to the rate of cooling (deg. F. per second through the critical temperature) at that point for the alloy under consideration.

A test called the "end quench" or "Jominy" hardenability test consists of impinging a stream of water on the end of a 1-in. bar. It is possible to reconstruct the hardness gradient across any size section, by plotting the hardness obtained from the end quench specimen to the cooling rate of the point in question. The speed of the test and the minimum material used account for its wide use.

Results of such tests indicate that an NE 8739 will cause trouble when submitted for large diameter because of insufficient hardenability. The solution is a water quench for large sections. The NE 8744 and NE 8749 will be satisfactory and the NE 8949 with a high hardenability must be watched to prevent quenching cracks for pinions or gears having excessive changes in section and sharp fillets.

Size of Section

For small sections, 1½ in. when oil quenched and 2 in. in water represented by ½ in. from the quenched end, all the steels shown will be satisfactory when maximum tempered hardnesses of 360 Brinell are used. For SAE 1045 or SAE 1050 steel a brine or other solution is required.

The end quench tests and other hardenability data are particularly useful for bar sizes under 5 in. in dia., which respond to a liquid quench. Larger sizes up to 30 in. require a heat treatment involving a simple air cool. The resulting hardenability is only dependent upon the alloy content.

An examination of the effects of the alloys upon hardenability shows that nickel can be reduced to 0.80 per cent minimum without great effect.

The mechanism of metallographic transformations is entirely different for air-quenched than for liquid-quenched steels. The hardness of the air-quenched specimen is substantially identical to the quenched hardness regardless of the tempering temperature. Hence, hardness specifications for medium to large sections liquid quenched should not exceed 240 Brinell.

NE alloy steels will require greater care in heat treatment because they are subject to greater variations, within the given normal specification ranges. In the war effort a careful check on so-called defective materials is necessary. Defective forgings of large size may be repaired and salvaged by welding. So called "sub-quality" steels may have to be accepted.

The Army, Navy and Air Corps are issuing lists showing allowable NE steels which can be substituted for their previously issued specifications. There is no assurance that the quantities of alloys in the present NE steel will not be reduced. Nickel will not be able to meet the demands. Molybdenum will be further restricted, manganese and chromium are in a slightly better position. Vanadium, tin and copper are definitely, "scarce." Full cooperation between the engineer and metallurgist are therefore required.

—E. J. Wellauer, *Machine Design*, Vol. 14, Nov. 1942, pp. 66-69, 146, 152-156.

Heat Resistant Alloy Castings

Condensed from "Canadian Metals and Met. Industries"

The success or failure of a high temperature alloy unit involves many features not encountered in ordinary engineering practice. Information given here regarding design strengths and analysis has been proven useful in actual successful installations by Fahralloy Canada, Ltd.

The terms "heat resistant" or "heat resisting" now designate alloys for use at temperatures, where iron and steel or nonferrous alloys fail, due to oxidation or high temperature corrosion. The range is from about 1200 to approximately 2150 deg. F.

The utility of an alloy for a given high temperature service is usually measured by

ZINC ALLOY DIE CASTINGS RESIST SUDDEN SHOCK

A shock absorber goes to war

Every time a "jeep" bounces down on its axles, zinc alloy die castings are undergoing a complex impact and compression test—from which they emerge with flying colors. The load-carrying parts of "jeep" shock absorbers (see illustration) are die cast of zinc alloy.

This use of die castings is not new. The same type of absorbers have been used on passenger cars for years. As a matter of fact, it is the pre-war service record of these absorbers which has resulted in their adoption for "jeeps." The entire recoil shock of the absorber is transmitted through 2 of the 3 zinc alloy die cast parts.

In one issue of "The Alloy Pot" considerable space was devoted to a discussion of the strength characteristics of zinc alloy die castings. A copy of this issue will be sent to you promptly upon receipt of a request on your Company letterhead.

A WEAPON FOR CLOSE QUARTER FIGHTING

Reports from Guadalcanal tell us that the elusive Jap appears from nowhere to face the advancing marine in the jungle. Such an experience is one that most of us at home can only dimly imagine, but it is reassuring to know that our marines are equipped with the efficient fighting tool shown below to cope with such a situation.

There is nothing remarkable about the construction of this stiletto, but it has been carefully designed from three standpoints. (1) The blade is of finest grade steel to avoid breakage. (2) The zinc alloy die cast handle has a knurled surface to guarantee sure grip. (3) The blade is inserted deeply into the handle in the die casting operation to achieve permanent assembly of the two parts.

Go to it, Marine—they asked for it!

The steel blade is cast as an insert in the handle

THE ALLOY POT

New Jersey zinc

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A publication issued for many years by The New Jersey Zinc Company to report on trends and accomplishments in the field of die castings. Title Reg. U. S. Pat. Off.

METALS AND ALLOYS EDITION No. 6

ECONOMY DOES NOT ALWAYS RULE

Cost is not always the determining factor in product design. Although low cost and die casting are synonymous, many zinc alloy die castings are chosen primarily for other inherent qualities.

Consider, for example, the reflector in the Signal Corps flashlight shown below. Although a reflector could probably be produced as economically by some other means, this reflector is die cast of zinc alloy to gain certain specific properties. The principal requirement here is rigidity—to assure retention of the true parabolic curve of the reflector during finishing operations, as well as in subsequent use. As a zinc alloy die casting, rigidity is obtained in the bowl of the reflector, and its solid screw base is integrally cast.

The elbow head of the flashlight is also die cast of zinc alloy. This one-piece construction avoided expensive forming and assembling operations.

A rigid reflector and a low-cost elbow head

one or more of these high temperature characteristics:

Chemical:
- Surface stability or resistance to oxidation or attack by surrounding media.

Physical:

Hot characteristics:
- Strength or load carrying ability.
- Stability against age hardening or phase change phenomena.
- Specific heat and heat content.
- Heat transfer factors.
- Electrical properties.

Cold Characteristics:
- Machinability
- Toughness.

Surface Stability

Any alloy is only best with reference to one given set of conditions. In overall efficiency in commercial units it is necessary to combine surface stability with the essential physical and mechanical properties.

Surface stability in metals and alloys at high temperature is due to one of the following:

(1) Intrinsic inertness under conditions of exposure.
(2) Formation of an adherent, impervious protecting compound through non-progressive reaction between metal or alloy constituent, and one or more corrosive agencies to which it is subjected.

Most of the rare metals and several other elements fall in the first class while industrial heat-resisting alloys are of Type 2.

All alloys will carbonize in a "carbon monoxide" or hydrocarbon atmosphere at high temperatures. With fuels having over 1 per cent S, nickel alloys must be kept below 12 per cent Ni and about 23 per cent Cr. In roaster gases the most satisfactory type contains 28 per cent Cr and 2 per cent Ni.

Physical Strength

Physical strength must be considered in combination with surface stability. Normal tensile tests should never be used, as load carrying ability of high temperature members over long periods is very much lower. The following standard alloys, each having some outstanding combination of surface stability and working strength, have been chosen and roughly grouped as:

1. Chromium-iron plus minor constituents.
2. Chromium-nickel plus minor constituents.
3. Chromium-nickel-iron, ternary series.

Group No. 1: These alloys have the lowest strength of any within the range possessed of high surface stability. They are used only where compelled by requirements of corrosion resistance.

Group No. 2: These are used chiefly as resistor heating elements in rolled wire or ribbon form.

Group No. 3: With chromium between 25 and 30 per cent, the best results have been obtained with nickel at 11 to 13 per cent. With chromium between 16 and 20 per cent, greater strength and other valuable characteristics are added when the nickel is between 30 and 40 per cent.

A standard grade with 18 per cent Cr and 65 per cent Ni has merit for carbonizing containers, retorts, etc, and for contact with certain fused salts and slags. It is superior for repeated and drastic temperature fluctuations and gradients, and where a high degree of phase stability and freedom from age hardening is required.

Alloys with a lower chromium and nickel range — the 18 and 8 analysis — are useful in temperature up to 1600 deg. F. In ranges from 1100 deg. to 1400 deg. F. chromium cast iron or low chromium steel can be used.

Minor Constituents

In general, increased carbon content lowers high temperature strength in high nickel alloys and raises it in high chromium classes. In chromium-iron alloys, the high temperature strength increases with carbon content up to about 1.25 per cent C.

Manganese, up to several per cent may be present without serious weakening effect or substantial decrease in surface stability. Silicon at 2.5 per cent will more than halve the strength found with a 1.25 per cent content. High silicon content improves castability. A small percentage of aluminum increases resistance to oxidation but lowers high temperature strength when the amount is over 1 per cent.

Due to high solid friction volume shrinkage, it is difficult to thoroughly feed alloy castings, with consequent danger of internal porous sections. It is also difficult

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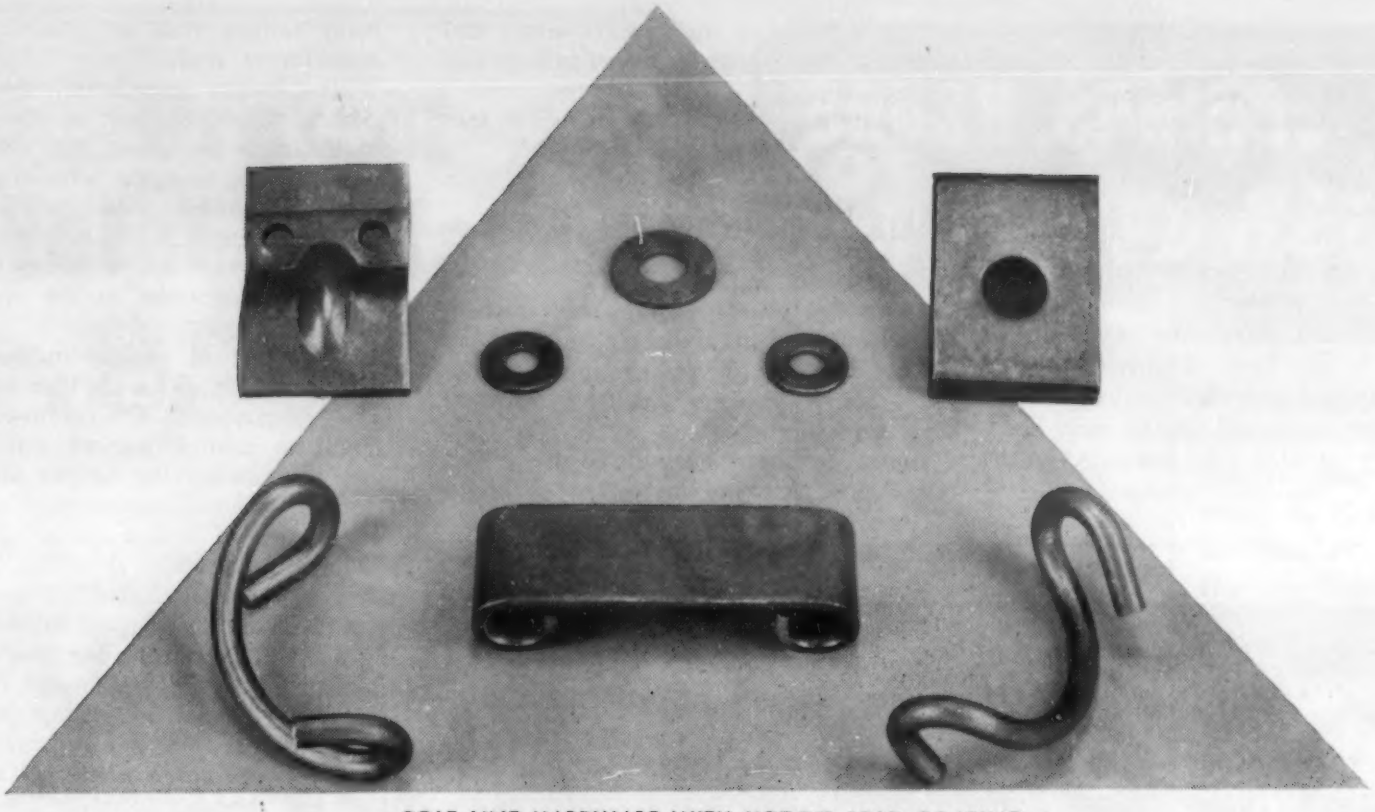

POLE LINE HARDWARE WITH HOT-DIP LEAD COATING

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Lead's resistance to the action of sulphuric acid makes it available to replace rubber linings, pipe, et cetera.

Considerable substitution of lead-base for tin-base bearing metals has already been accomplished.

Hard lead (antimonial lead alloy) is replacing brass in plumbing installations and is being used for name plates and instruction plates.

Shortage of tin has resulted in the development of much thinner lead foil, and of collapsible tubes without any tin.

Lead-base die-castings are being substituted for zinc-base die-castings.

Gaskets and washers in many cases can be made of lead instead of rubber.

Lead welding can be used to replace soldering in many instances, thus saving tin.

Industry realizes how important it is to develop substitutes for scarce materials, and is really doing a job in this field.

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to prevent draws or checks at corners or where section changes occur. Therefore rapid sectional changes should be avoided. A unit may be broken up into parts and joined afterwards.

Stresses set up by temperature fluctuations cause more failures in high temperature mechanisms than all other causes. High temperature structures should, where possible, be broken up into small units. Most of the common types of alloys can be obtained in the form of sheets, bars, centrifugal castings and sand castings and often the most successful design may be obtained by a suitable combination. Sand castings are generally stronger than wrought forms in high nickel alloys and always seem to resist distortion to a greater degree.

—T. G. Beament, *Canadian Metals & Met. Industries,* Vol. 5, Oct, 1942, pages 292-295.

Crankshaft Design and Fatigue

Condensed from "Engineering"

In this report of fatigue tests of full-size crankshafts for diesel-type engines the authors first describe the testing machines used, which were of the constant-strain type, the object being to apply repeatedly a known bending movement to one crank-throw at a time and thereby to obtain as many fatigue tests as possible from one multi-throw shaft.

Six designs of chromium-nickel steel crankshafts were tested; in one case shafts of the same design in two steels of different tensile strengths were available. The results indicated that the decrease in fatigue strength, due to the use of a steel of lower tensile strength, was almost in proportion to the reduction in tensile strength.

The effect of various methods of surface hardening on the fatigue strength was also examined. Chromium-plating was found to have a marked detrimental effect in reducing the fatigue strength. Induction hardening treatment caused, in general, a loss of fatigue strength, the results being erratic; this reduction in fatigue strength was attributed to the residual stresses induced adjacent to the hardened zone, but it is possible that induction hardening may be detrimental if the maximum applied stress is just outside the hardened zone, but may be beneficial if the point of maximum stress is within the hardened zone.

Tests with nitrided shafts revealed that these had an appreciably greater fatigue strength, the increase being of the order of 25-60 per cent. This is probably largely attributable to the compressive stresses induced by nitriding.

—C. G. Williams & J. S. Brown, *Engineering,* Vol. 154, July 17, 1942, pages 58-59; July 24, 1942, pages 78-80 (abstracted in *Bull. Iron & Steel Inst.,* No. 81, Sept. 1942, page 184 A.)

Welded Machine Tools

Condensed from "Welding"

For years cast iron has been the standard material for machine tool bases and bodies, because of its rigidity, vibration damping capacity, low cost and superior machinability. Certain difficulties have arisen, however, from the occasionally inadequate mechanical properties of cast iron and certain features of the casting process.

To avoid the danger of cracks in press uprights, which are subject mainly to bending and tensile stresses, the use of preloaded steel bolts was introduced, but the substitution of mild steel fabrication for cast iron could not be made until designers abandoned the idea of copying the cast iron design and introduced new lines of construction. The author emphasizes the fact that resistance to heavy tensile stresses was the main factor which led to the adoption of fabricated steel construction.

Heavy presses and press uprights, base plates, lathe beds, planing machine, milling machines, and surface grinders of fabricated steel are discussed in detail from the designer's point of view. Designers are reminded that complicated fabricated structures, *e.g.,* the knee of a universal horizontal milling machine, if they are to be produced in quantities, do not seem able to compete economically with a casting.

In designing for production, the drafting room and the planning department must collaborate before manufacture. When a welded design has been chosen, the exact welding procedure should be indicated by the drafting room.

—F. Koenigsberger, *Welding,* Vol. 10, May 1942, pages 75-78; June 1942, page 107-110 (abstracted in *Welding Lit.* Review, Vol. 4, Aug. 1942, page 744.)

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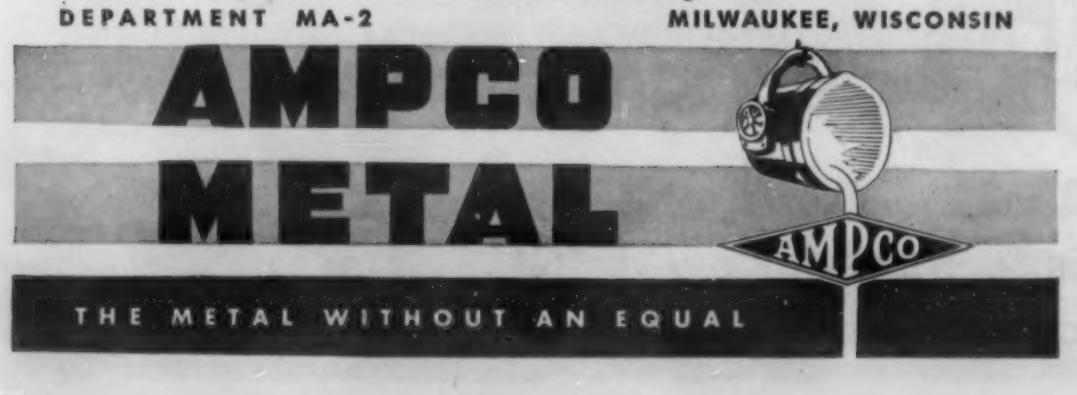

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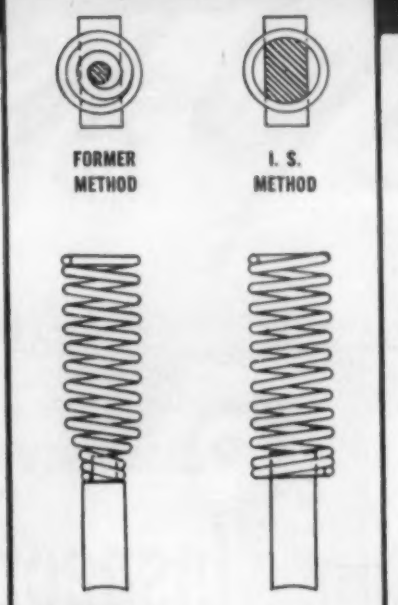

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Temperature Control of Galvanizing

Condensed from "Iron & Steel Engineer"

In the hot dip galvanizing process, spelter temperature affects the cost of heating, the rate of dross formation, the life of the galvanizing kettle, and the structure of the galvanized coating. Therefore, to minimize the effects of variations in spelter temperature, automatic temperature control is applied.

The characteristics inherent in the system favorable to constant temperature control are:

1. Large demand side thermal capacity. This is the amount of heat required to raise the spelter temperature one degree. It is directly proportional to the volume of spelter.

2. Small supply side thermal capacity. This is the heat required to raise the temperature of the refractory setting surrounding the kettle one degree. Decreasing the mass and specific heat of the refractory decrease it.

3. Minimum temperature difference between supply and demand sides. This is the difference between the refractory setting surrounding the kettle and the spelter contained in it. For kettles requiring the same heat input, increasing the kettle heating surface and decreasing the thermal resistance between setting and kettle decreases this difference.

4. Minimum transfer lag. This is the time interval required for a change in the rate of heat input to the refractory setting to produce a corresponding change in spelter temperature. It can be reduced by decreasing the supply side thermal capacity of the kettle and the resistance between setting and kettle.

Temperature Control Instruments

Control instruments have been developed to minimize differences in kettle characteristics. A thermocouple located in the spelter bath measures spelter temperature. A two position, on-off controller attempts to regulate the bath temperature by positioning a valve in the fuel supply line.

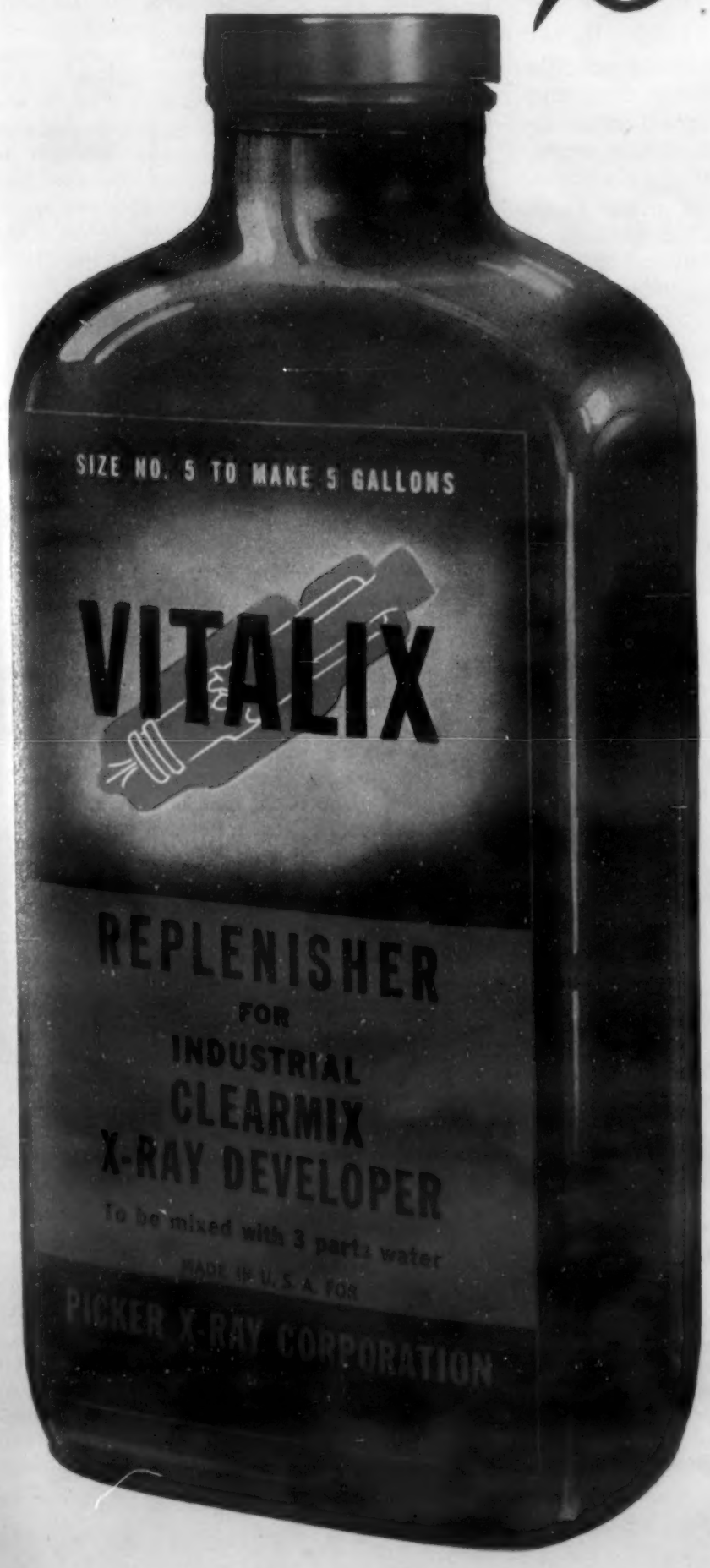
Taking as examples two kettles "A" and "B," of which "B" has the above listed favorable control characteristics and "A" does not, "B" is found more favorable to temperature control.

In each case when the spelter temperature is below the control index, the fuel valve is open. As the temperature rises above the control index, the controller closes the valve. Because of the heat stored in the supply sides, the spelter temperatures continue to rise. However, the heat stored in kettle "B" is less than that in "A" because its supply side thermal capacity is less and its supply side temperature is lower. In addition, more heat per degree is required to raise the spelter temperature of "B" because its demand side thermal capacity is greater. Therefore the temperature rise above the control index is less in kettle "B" than in "A."

There are two other general classes of temperature controllers: the proportional position control and the proportional position control with automatic reset.

In the former, the position taken by the

Best by test



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fuel control valve is proportional to the temperature deviation from the control index. The temperature span between the fully opened and fully closed valve position is termed the "throttling range" of the instrument. The more favorable the process characteristics, the narrower the range may be, to produce a uniform controlled temperature curve.

With the proportional position controller, the controlled temperature does not necessarily coincide with the control index. For example, to produce a uniform spelter temperature curve, the throttling range of the controller must be wider for kettle "A" than for "B." Therefore the deviation from the control index would also be larger, and the temperature span between the high load and low load curves greater.

The automatic reset feature shifts the throttling range with respect to the control index. The controller attempts to counteract the effects of heating load changes on controlled temperature by repositioning the fuel control valve. The more favorable the process characteristics, as in kettle "B," the more nearly the controlled temperature curves coincide with the control index.

All automatic-temperature controllers presuppose that the heat input to the refractory setting is at least roughly proportional to the control valve position.

Controlling Spelter Temperature

With respect to control of spelter temperature, a galvanizing kettle installation may be broken down into four parts:

1. Kettle size: Most kettles are designed to provide sufficient spelter volume to aid in maintaining constant temperature and also a reservoir in the bottom for the accumulation of dross; to accommodate the overall dimensions of the material being galvanized; and provide sufficient immersion time in continuous installations. The following figures are a guide:

A. Allow 50 cu. ft. of kettle volume for each net ton of steel galvanized per hour.

B. Allow 1 sq. ft. of exposed kettle heating surface for each 12,000 B.t.u. per hr. heat input through the kettle walls. The majority of the heat should be applied to the upper third of the kettle, in such a manner as to prevent overheating of the kettle walls. The extreme top portion should be protected by a refractory.

2. Refractory setting: The mass of refractory used in the setting should be kept at a minimum. Whenever possible the use of light weight refractory of low volumetric specific heat is recommended.

In electrically heated kettles, surrounded by a simple wall of low specific heat refractory, supply side capacity is very low. This is also true of radiant tube firing.

In several of the conventional externally fuel-fired setting designs, refractory mass and volumetric specific heat are high. The resulting combination has an unfavorable result on the control characteristics of the kettle.

3. Heating equipment: In selection, the cost, availability and ease of control should be considered. In all installations it is desirable and in some necessary to shut off

STANDARD'S NEW AUTOMATIC X-RAY UNIT

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AS MODERN AND AUTOMATIC AS YOUR TURRET LATHE

Operable by unskilled workers

Ideal for routine inspection on a real production basis

As shown at the recent National Metals Congress, the "Industromatic" X-ray unit was designed by Standard engineers to save time and labor in the busy industrial plant. Almost entirely automatic and operable by unskilled workers, this up-to-the-minute x-ray apparatus speeds up routine inspection of metal from thin aluminum to 1¾ inch steel. As modern as today's turret lathes and screw machines, the "Industromatic" places heretofore s-l-o-w testing procedures on a real production basis.

Incorporating features never before employed in any x-ray equipment, yet simple and easy to operate by workers without a knowledge of radiography, the equipment illustrated here is capable of taking care of a major part of today's production needs.

The Model "C" comprises the high Tension Transformer Unit, including two oil immersed valve tubes. A substantially designed Tube Stand on which is mounted a shockproof x-ray tube unit with high tension interconnecting cables. An automatic Control Panel incorporating an 8-position technique selector switch that automatically delivers the correct combination of technical factors such as—time, kilovoltage and milliamperage for the particular job at hand.

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the heat input during parts of the temperature cycle. Electricity is most readily adapted for this. With gas or oil, provision must be made to insure their ignition after control periods of zero fuel input.

Multiple burner firing or a large number of small burners is advantageous for proper distribution of heat. For low individual burner capacity, gas is more suitable than oil. With multiple burner firing, the burners, either oil or gas, may be arranged in groups, and one or more groups shut off during parts of the temperature cycle.

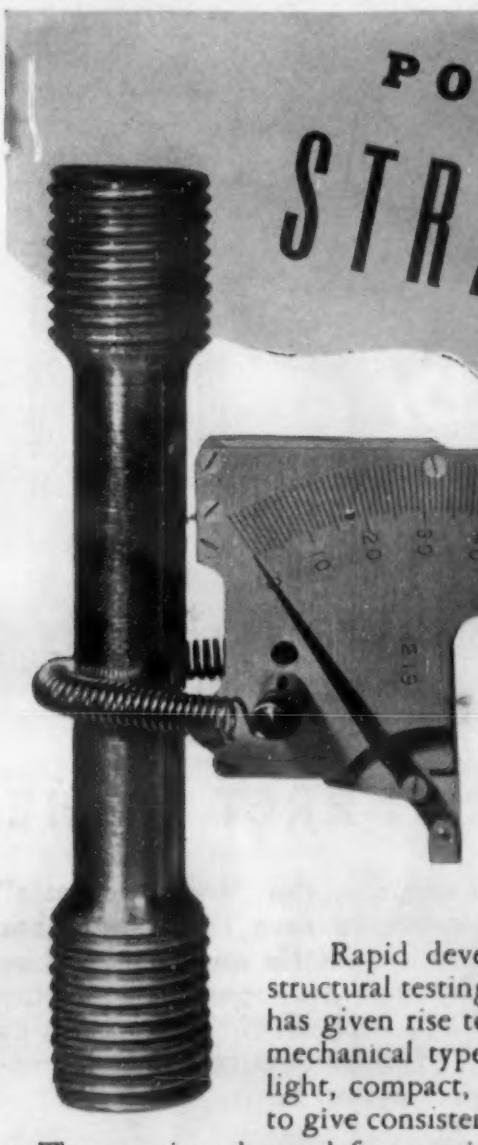
Forced convection heating, or the forced recirculation of flue products around the kettle walls has been used. The resulting flue gas velocity lowers the resistance to the transfer of heat between setting and walls with a corresponding decrease in required setting temperature. However, the additional flues and circulating equipment add to the supply side thermal capacity of the setting.

Fouling of the kettle surface by zinc oxide or soot increases resistance to heat transfer. The resulting increase in setting temperature necessary to maintain required heat input has an unfavorable effect on control characteristics.

4. Control equipment: In selection, the advice of the various instrument manufacturers is recommended. Control arrangements, specifically applicable to the special case of the galvanizing kettle, are available. In one, a secondary thermocouple limits the maximum setting temperature. In another, cold air blown into the setting surrounding the kettle reduces the increase in spelter temperature following heat load reductions.

The control installation must be protected from fume and dirt. Its location in an enclosed gage house adjacent to the kettle is recommended.

—Howard Halstead, *Iron & Steel Engineer*, Vol. 19, Nov. 1942, pages 64-70.



PORTER-LIPP

STRAIN GAGE

Accurate

Light

Compact

Prompt Delivery

Rapid development of the volume and technique of structural testing in the United States during the past decade has given rise to the need for an all purpose strain gage. A mechanical type of gage that is accurate, yet inexpensive, light, compact, rugged and convenient is desirable in order to give consistent results in both the laboratory and the field.

The pressing demand for a satisfactory strain gage in the present time of emergency, during which European sources of instruments have been cut off, finds the Porter-Lipp strain gage filling a definite need for a superior instrument of this type.

The strain multiplication factor of this gage is approximately 300 and it has a range of 0.008 in. or better. Weighing only 0.4 oz. the Porter-Lipp has overall dimensions of 1¾ in. by 2 in. by ⅝ in. It is graduated so that each division corresponds to a strain of approximately 0.0001 in. and has a readable accuracy of 0.00002 in. for a gage length of one inch.

Write for our new bulletin No. 166

Baldwin Southwark

DIVISION OF THE BALDWIN LOCOMOTIVE WORKS

PHILADELPHIA

BLW THE BALDWIN GROUP

Electron Microscope "Replicas"

Condensed from "Journal of Applied Physics"

A simple method for making replicas of surfaces for use in the electron microscope is described. In this the surface is coated with a thin film of resin by dipping in a solution 0.5 per cent "Formvar" (polyvinal formal) dissolved in dioxane or ethylene dichloride and allowing the solvent to evaporate with the surface held in a horizontal position.

The film formed ranges in thickness between 500 to 750 A.U. in 2.5 cm. It is removed from the surface by placing it below the surface of water and peeling the film from the surface.

Data are given on the relation of film thickness to concentration of the resin in the solvent and methods for determination of the film thicknesses. A method for preparing strong films of 100 A.U. thickness and 3 sq. cm. area is given and methods for mounting specimens including a conditioning treatment are described. Five micrographs obtained by these methods are included.

—V. J. Schaefer & David Harker, *J. Applied Physics*, Vol. 13, July 1942, pages 427-433.

Tubular Creep Tests

Condensed from "Transactions," American Society of Mechanical Engineers

The results are published of tests on tubular specimens of carbon-molybdenum steel with 4 in. outside diam. of ⅜ or ⅛ in. wall, with hemispherical ends welded in place. They were tested under internal pressure by measuring circumferential and longitudinal creep and compared with a tensile test. All tests are represented in full by diagrams and tables, and a theory is developed to permit calculation of creep rates.

It is concluded that a tension test is available which gives the creep rate u at the stress. A tube of the same material is tested at the same temperature and at an internal pressure determined by p $2/\sqrt{3} \times st/R$ where R and t are mean radius and wall thickness in inches, respectively.

At this pressure, the predicted tangential creep rate, expressed as change in mean radius, is $\sqrt{3/2} \times u$ while the predicted

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New, Extra Fine Grain *TYPE M* Film has Exceptional Definition—"Made to Order" for Higher Voltages, Light Alloys, and Critical Inspection

Kodak Industrial X-ray Film, Type M, is a new, extra fine grain, high contrast film designed to meet the widening use of higher kilovoltages, the growing use of radiography in the examination of light alloys, and the increasing emphasis on critical inspection in industry, generally.

Type M's combination of extra fine grain—finer even than that of Kodak's Type A Film—and high contrast results in exceptional radiographic sensitivity . . . its superior definition makes extremely accurate inspection practicable.

Type M is particularly advantageous in most million-volt work . . . in the examination of thin parts of light alloys with lower kilovoltage equipment . . . and in other fields in which high film speed is relatively unimportant but critical definition is required. It can be used either for direct exposures or with lead-foil screens.

Type M is an important, timely extension of the line of films Kodak has produced for industrial use. The others are:

Kodak Industrial X-ray Film, TYPE A, which has fine grain and high contrast—and higher speed than Type M—particularly useful in the radiography of aluminum and magnesium at low voltages . . . and for million-volt radiography of thick steel parts.

Kodak Industrial X-ray Film, TYPE F, which has the highest available speed and contrast when used with calcium tungstate intensifying screens. It is also used for gamma radiography—direct and with lead-foil screens.

Kodak Industrial X-ray Film, TYPE K, which has the highest available speed in direct exposure . . . when used with lead-foil screens at higher voltages . . . and, for heavier parts, with gamma rays.

EASTMAN KODAK COMPANY
X-ray Division Rochester, N. Y.

axial creep is zero. The measured creep rate at the mean radius is obtained by increasing the measured creep rate at the outside radius in the square of the ratio of the radii, or $(1 + t/2R)^2$.

The tests extended over more than 9,000 hrs. For large wall thicknesses a correction must be applied; a formula for this is developed.

—F. H. Norton & C. R. Soderberg, *Trans. Amer. Soc. Mech. Engrs.*, Vol. 64, Nov. 1942, pages 769-777.

Workability Tests on Nickel Plate

Condensed from "Steel"

In an effort to develop a practical test for the routine determination of the physical properties of the nickel deposits on "prefinished" nickel-coated sheet-steel and copper, a standardized procedure was evolved requiring nickel deposits 0.010 to 0.020 in. thick. All deposits were tested for hardness on the Rockwell superficial machine and on the Tour-Marshall stiffness tester for development of stress-strain curves and an indication of ductility.

In these tests, a range of 45 deg. for deflection was used. The data obtained from the stiffness tester are plotted with the angle of bend against the bending load, resulting in a curve that resembles the stress-strain diagram.

The tests on nickel deposits indicate that a definite correlation exists between the ductility as noted by the Erichsen cup test and this "set angle" or "spring back," as well as the stiffness values obtained at 45 deg. The stiffness values are stress values and are obtained by conversion to standard thickness using an exponential value of the load somewhat less than the cube.

Stress-strain curves were made on several strip steels within the temper range, chiefly used for production of prefinished metals, and the set angle noted. No. 4 temper steel in general had a yield-point at stiffness values between 5 and 10. Maximum stiffness at 45-deg. angular deflection was 8 to 14. Set angle was 34 to 38 deg.

Comparative tests were made with the same steel on an Olsen universal tensile machine and the results corresponded roughly. Rockwell B hardness values were taken and, in general, these seemed to correlate well with the stiffness.

The ductility as indicated by the set angle did not show a numerical relation to the Rockwell values or to the actual elongation values obtained on the universal testing machine. However, there is some relationship, and actual performance in fabricating prefinished metal with these materials shows that these base metals are interchangeable for most jobs involving mild drawing, stampings, etc.

These ductile nickel deposits when applied to copper and steel, even when very thick, cause only slightly if any lower fracture values during Erichsen cup tests, when compared with those values obtained on uncoated base metal. Estimated tensile strength of the ductile deposits is 50,000 to 60,000 lbs. per sq. in.

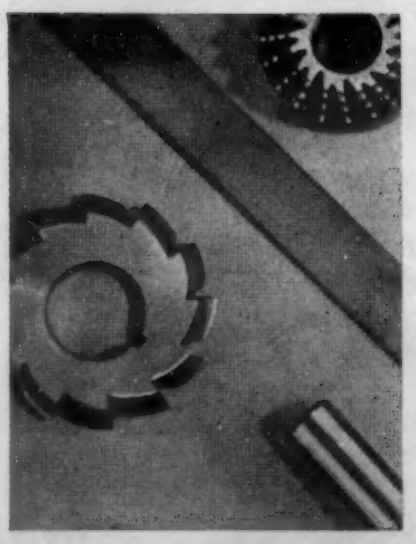
Medium hard nickel deposits, with hardness of 68 to 83 Rockwell B, had set angles of 25 to 28 deg. in general, and stiffness values at 45 deg. of 13 to 15.5, corresponding to tensile strengths of 70,000 to 80,000 lbs. per sq. in. The curves for these deposits did not show as definite a yield-point as did the curves for ductile nickel.

Hard nickel deposits, which showed bad cracking when exposed to a ball extrusion test, had set angles of 15 to 20 deg. and stiffness values at 45 deg. of 21 to 24, corresponding to tensile strengths of 96,000 to 102,000 lbs. per sq. in. in Rockwell B hardness was 81 to 100. The curves for these showed very indefinite yield-points, if any.

The stiffness testing method should be suitable for similar determinations of other electrodeposited metals and prove valuable for control when hardness, ductility, or other physical properties are desired. The main factors governing the hardness or ductility of nickel deposits were found to be composition, pH, most organic substances in general, and any materials that cause interference with grain growth. Current-density affected the properties only when other factors were most advantageous.

—F. P. Romanoff, *Steel*, Vol. 111, Sept. 7, 1942, pp. 98, 100, 104, 116-117; Sept. 21, 1942, pp. 86, 89.

Quick, Non-Destructive Test for Identification of NICKEL in Alloy Steel



The new Bowser-Morner Test Kit is an invaluable tool for differentiating between nickel alloy and other alloy or plain carbon steels . . . Employing the reagent "spot" test principle, it is simple to use and provides fast, positive recognition of as little as .20% nickel in stock or scrap alloy steel.

Complete Kit, with full instructions and sufficient material for a minimum of 500 tests, is priced at $12.50 (F.O.B. Dayton)

Purchase orders should bear priority extension.

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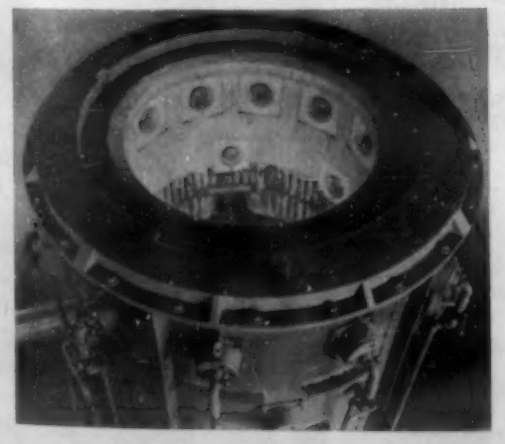
Radiant Heat for Magnesium Melting

For the first time the ceramic-cup radiant gas burner has been adapted to the firing of furnaces especially designed for magnesium metal melting by the *Selas Co.*, Erie Ave. and D St., Philadelphia. This application fosters greater uniformity of heat delivery over the sides and bottoms of magnesium melting pots and permits lower temperature gradients through pot walls without sacrifice of speed or efficiency.

In the accompanying photograph is the largest of 15 units recently built for use in four war plants. It will hold 2,000 lbs. of metal in a pot slightly over 3 ft. in both diameter and depth. It can ladle out 600 lbs. of metal per hr.

Eighteen Type-K-670 all-ceramic radiant-cup gas burners are employed — 12 in the top row, 6 in the bottom. Pre-mixed gas and air is delivered at 12 to 15 in. w.c.



manifold pressure to each burner through an individual line and manual valve, thus balancing rates of heat input over the pot surface.

Once the balancing valves are set, single-valve, two-point control, actuated by a thermocouple in the molten metal, operates to throttle or open the manifold mixture supply to all burners at once and automatically maintain a pouring temperature of 1350 deg. F. in the pot at all times.

An auxiliary thermocouple in the combustion chamber is connected into the control system so that a maximum outside pot temperature determined by the user can never be exceeded, making for safety, uniformity of metal temperature and long pot life.

There are at least eight interesting design features: (1) Split manifolding, each of three being protected independently against backfire; (2) two large opposed clean-out doors; (3) refractory-lined emergency run-out spout with 3 in. opening; (4) bottom venting; (5) burner view-holes for inspection of cup-radiation; (6) split cast-iron top ring for long life; (7) 2-in. fire extinguisher openings around the pot rims; (8) hard-burned refractory facing on floor and sidewalls to resist molten metal should pots rupture or leak.

Speed Results from Induction Heating

Heating a propeller blade shank for two important forming operations in about one-fifth the time formerly needed is accomplished by the Tocco process of electrical induction, perfected by the *Ohio Crankshaft Co.*, Cleveland.

The shank of the hollow blade is first Tocco heated preparatory to swaging, where the shank is rounded to a perfect circumference. The blade is mounted on a movable rack at the front of the 100 kw. Tocco machine. The tubular shank section at the blade's base is then moved forward until surrounded by heat inductor coils. An enormous amount of internal molecular

friction is set up in the shank, heating it to 1700 deg. F. in 150 sec.

Next, it is conveyed to a huge National forging machine capable of 27-ton pressure. After each application of dies the shank is turned a quarter revolution until it is swaged into a true cylindrical shape.

Then the blade passes through two welding processes, inspection and a lathe operation, and heated a second time in the Tocco unit for 210 sec. to 2200 deg. F. The crane then conveys it to the adjacent upsetting equipment. This forms the heated shank in a three-pass set of dies to increase the wall thickness of the shank from .520 in. to 13/16 in., decreasing the length of the shank area from 12 5/8 to 9 3/16 in.

By previous processes the shanks were heated by gas furnaces. Fifteen minutes were needed, and the worker judged correct temperature by the color.

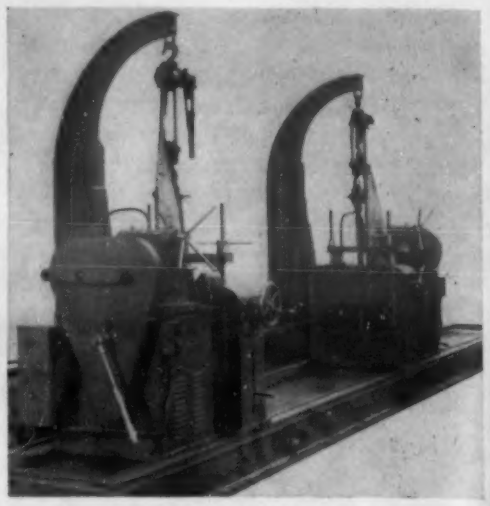
In the accompanying photo the shank is being heated to 2200 deg. F. prior to upsetting.

● A new steel, "Speed Case," has been developed to meet the need for a steel with machinability of S.A.E. 1112 and X1112 Bessemer screw stock and the strength of such open hearth steels as S.A.E. 1020, X1020, X1314 and X1315. The steel is a result of a new process embodying both chemical and temperature controls for the production of low-carbon, open-hearth case carburizing steel. It is made by *W. J. Holliday & Co.*, Indianapolis. Forge shops are being licensed under Speed Case patents to produce forgings and forged bars, which offer properties hitherto unattainable in a forging steel.

Double End Centering Machine

A machine for centering both ends of large work, such as gun forgings, is announced by *Kent-Owens Machine Co.*, Toledo, Ohio. The work is freely suspended in slings and is easily adjusted into position by two davits, each with chain hoist. This permits locating the centers in the approximate center of gravity of the piece, a marked improvement over the geometric center method. Work can be handled up to 14 in. in diam. and up to 19 ft. long. Elements are adjustable along the base for setting for a given job.

While suspended, a vertical line is scribed across each end by a square rest-



ing on a surface plate and located against a centering gage above the sling. The work is rotated slightly and another vertical line is scribed, etc. The intersection of these lines indicates the gravity center. Then the work is lowered into the V-blocks of the two work supports.

The first tool on each head is fed into the work and withdrawn by hand by the star hand wheels. Heads are moved laterally by a hand lever and properly indexed into position for the second tool by a simple spacing arrangement. Final centering tools are then fed into the work, as were the first tools.

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AB LEAD LAPPING DISC for producing extreme flatness in polishing difficult metal specimens with a minimum of disturbed metal.
EYE SHADE MAGNIFIER—Large clear field — magnification 2¼ times. Quick change to normal vision by simply pushing up on forehead.
B. & L. WIDE FIELD BINOCULAR. Affords a wide field of realistic three-dimensional vision. Shown with B. & L. reflector lamp.
AB DE LUXE POLISHING MACHINE combines maximum convenience with precision polishing. Built in wash fountain—air blower for drying—desiccator compartment for sample preservation.
APLANATIC FOLDING MAGNIFIERS Single lens—6-power.
Double lens type with 6- and 3-power lens. 9-power when combined.
B. & L. FOLDING MAGNIFIER in metal case. 7-power.
SPECIMEN MOUNT PRESS No. 1315, provides utmost ease and speed in molding and cooling bakelite and transoptic mounts, either 1" or 1¼" size. Built for extreme accuracy and long service.
A complete line of equipment for the Metallurgical Laboratory . . .
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OPTICAL INSTRUMENTS ★ METALLURGICAL APPARATUS
228 North LaSalle Street, Chicago, Illinois

Foot-Controlled Hydraulic Arbor Press

Speed is the chief factor claimed for the new Speedpress (hydraulic arbor press), made by the *Studebaker Machine Co.*, 9 S. Clinton St., Chicago. It is entirely foot-controlled and easily operated by women.

Pressures from zero to 20,000 lbs. are obtained by pedal. All Speedpress work is handled: Broaching, assembling, piercing, oil-grooving, riveting, sizing, flanging, staking, forcing, small die tryouts, forming and pressing operations.

● Properties of 96-4, Aluminum-Copper (Casting Alloy) are compared between the casting process and powder metallurgy method by the *Hardy Metallurgical Co.*, 420 Lexington Ave., New York. Thus, by the cast method, the solution treatment at 960 deg. F. took 12 hrs.; powder metallurgy sintering, 30 min. For precipitation treatment at 370 deg. F., the time was the same in both, 4 hrs. Tensile strength (cast) was 22,000 as against 34,000 sintered, with elongation, cast, 3 per cent; sintered, 10 per cent. Solution and precipitation, (cast) 32,000 tensile, 3 per cent elongation; by powder, no solution treatment needed; precipitation treatment, 38,000 tensile, 10 per cent elongation. Rockwell "B" (cast) was 50; powder, 45.

Salem's Ingenuity Applies to Furnaces And Auxiliary Handling Equipment

Example, Bomb Heat Treating and Handling is Now Only a 3 Man Job

● The outstanding performance of Salem furnaces may well be attributed to Salem's experience and knowledge of plant production operations. Salem, therefore, builds and designs furnaces as well as auxiliary handling machinery, which co-ordinates the operations of all equipment to speed production and lower costs. With this thorough understanding of manufacturing procedure, Salem engineers can also offer dependable furnace designs which will dovetail into existing handling mechanisms. The bomb heat treating furnace, pictured above, gives evidence of Salem's complete engineering service. The furnace and quenching equipment, including conveyors, racks, charging and discharging apparatus, are all of Salem design. This war equipment . . . big and important as it is . . . requires only THREE MEN for operating as well as supervision. Write to Salem about your problem—use Salem's experience in war production equipment.

SALEM ENGINEERING COMPANY

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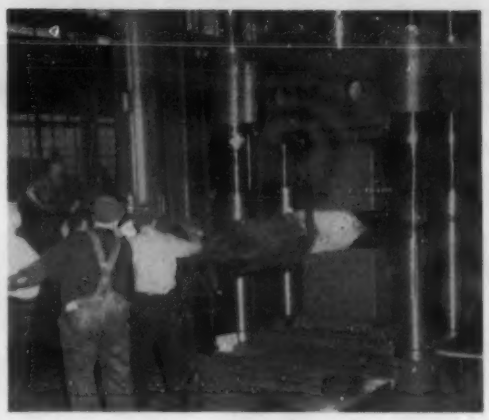
Self-Contained Open Forging Press

A new 1000-ton H-P-M Fastraverse, self-contained open forging press has been demonstrated recently by the *Hydraulic Press Mfg. Co.*, Mt. Gilead, Ohio. It is quite dissimilar to the conventional steam-hydraulic press, which requires many auxiliaries such as boilers, accumulators, intensifiers, reciprocating pumps, etc.

In contrast is the H-P-M self-contained unit with motor-driven hydraulic pumps mounted directly to the press cylinder. It provides for prefilling and exhaust of the main cylinder during rapid traverse



ram movement. It closes and opens at a rate of 560 in. per min., and has a pressing speed of 105 in. per min.

Its ram travel is reversed without an operating valve. Instead, the radial pump is reversed, which provides smooth, shockless reversal controlled by remote hand lever.

● Ideal for women operators, releasing more skilled production men for other work, is the new Diebel Hi-Speed stamping press, according to its manufacturers the *Di Machine Corp.*, 3654 Lincoln Ave., Chicago. The press automatically produces small stampings of metal, fibre, plastics and other materials at speeds of 180, 370 and 500 strokes per min.

DEMPSEY industrial furnaces

Pouring from one of five aluminum melting furnaces at the Cincinnati plant of Wright Aeronautical Corporation

Tomorrow is Important Now!

We point with pride to the fact that DEMPSEY Furnaces were selected by such firms as . . .

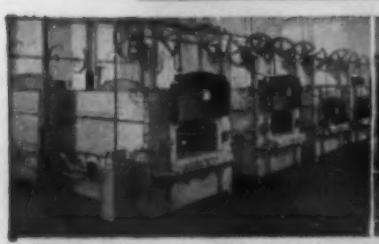
Buick Motor Div.—Gen. Motors
Ford Motor Company
Bohn Aluminum & Brass Co.
General Electric Company
Bethlehem Subsidiaries
Wright Aeronautical Corp.

and many others.

BUY MORE WAR BONDS

Even in the stress of today's unprecedented war production schedules, wise management must think of tomorrow! In the selection of heat treating equipment, Dempsey Furnaces are the obvious choice. They are engineered to deliver maximum performance at lowest cost, high efficiency and trouble-free operation. Rugged, sturdy construction insures years of service during and long after the war.

WRITE FOR BULLETINS



Carburizing, annealing and general heat-treating oven furnaces.

Pot furnace for heat treatment in liquid bath.

Continuous pusher type hardening furnace, automatic quench, and continuous belt conveyor type draw furnace.

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SPRINGFIELD, MASSACHUSETTS
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DEMPSEY FURNACES since 1917 • GILBERT & BARKER since 1908

DEMPSEY FURNACES

Fuse-Bond, Preliminary to Metallizing

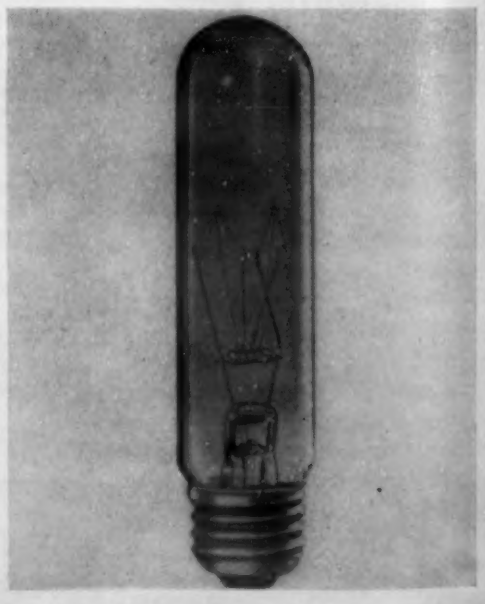
Machine components and similar metal parts now may be prepared for metallizing electrically by the Fuse-Bond process of the *Metallizing Engineering Co., Inc.*, Long Island City, N. Y. It affords an adequate bond on the hardest surfaces, heretofore impossible or impractical to prepare by blasting or rough threading. It also simplifies preparation of narrow edges, flat areas, and cylindrical parts having keyways, etc.

The Fuse-Bond unit fuses a rough deposit of electrode metal into the surface to be metallized. Electrodes are applied with a special holder, using up to six electrodes at a time. Small parts may be prepared as easily as large shafts, since there is no excessive heating of the base metal or disturbing of its physical characteristics.

The cabinet is 2 ft. high, weighs 170 lbs., and is mounted on casters.

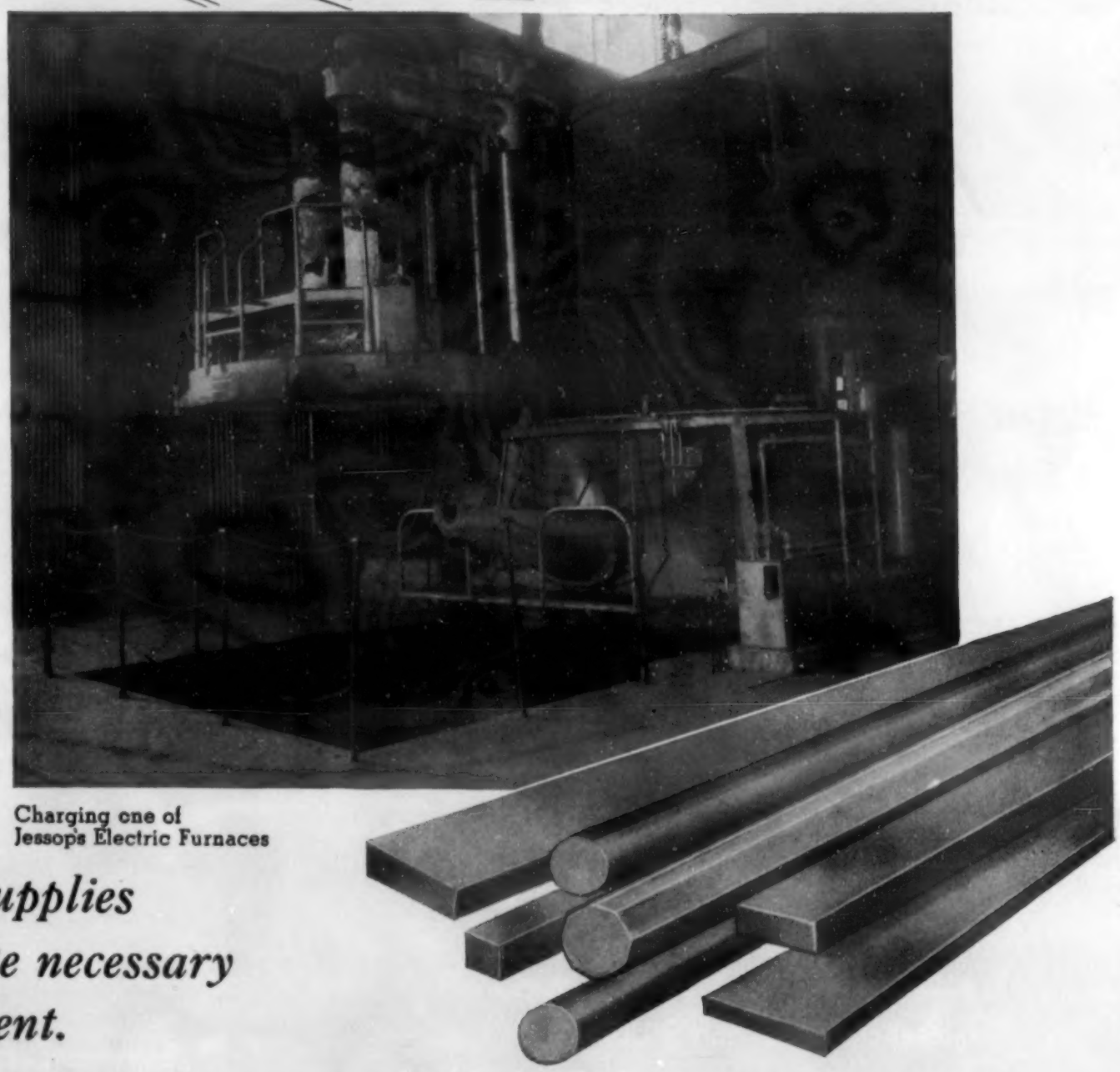
Spatterproof Lamp for Welding

A new type spatterproof lamp for welding and rough industrial service has been introduced by the *Radiant Lamp Corp.*, 260 Sherman Ave., Newark, N. J.



It is made of a special glass that resists penetration of hot metal particles and will withstand severe handling. Sizes range from 50 to 150 watts.

There is no Substitute for EXPERIENCE



Charging one of Jessop's Electric Furnaces

Experience supplies the knowledge necessary to advancement.

• Jessop men are specialists in the art of making fine alloy specialty steels. Behind them are the standards of Jessop quality built up through years of experience. Efficient metallurgical and chemical supervision control every manufacturing step using modern production facilities and practices. Control begins at the scrap pile, for quality depends first on selection of raw materials. Charges are melted in electric arc furnaces. Utmost care is used in forging, rolling, and treatment.

Jessop's wide experience assures reliable assistance in solving problems relating to selection and application of tool steels. Our warehouses are located to assure prompt service. Jessop Steel Company, Washington, Pennsylvania.

Est. 1901

Jessop Steels

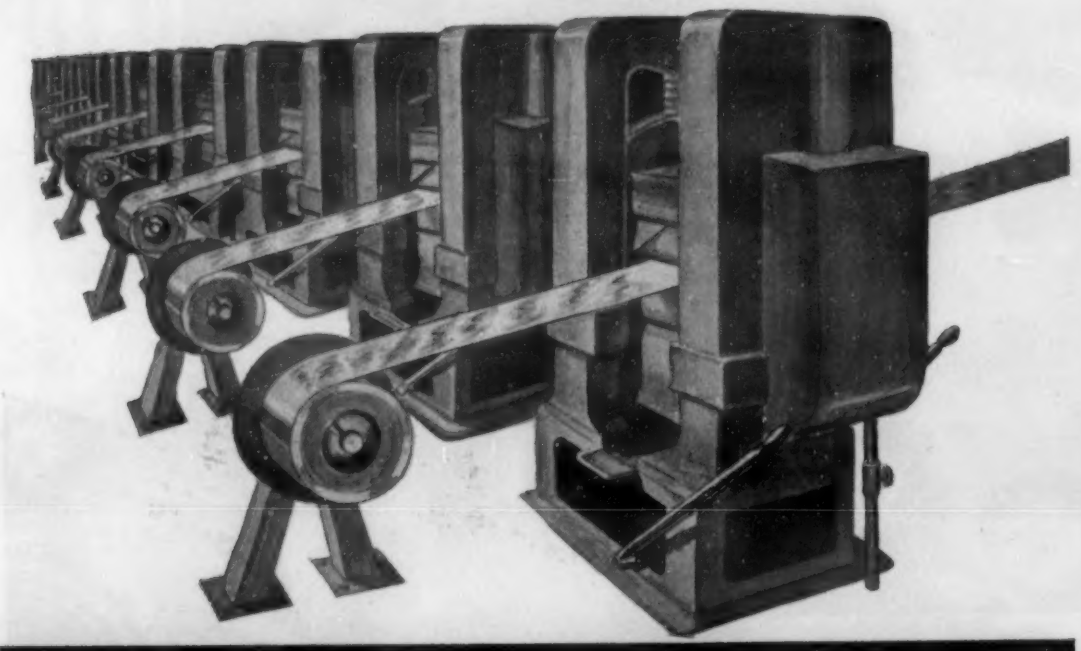
Carbon · High Speed · Composite Tool Steel · Special Alloy · Stainless · Stainless-Clad (Silver-Ply)

Now Works for Living Instead of Dead

Instead of working for the dead, the *George F. Ames Co., Inc.*, Lynn, Mass., switched to services for the living, with the ultimate purpose of making dead certain Germans, Japs and Italians. The Ames Company has turned out tombstones for 48 years. They have now become subcontractors for the General Electric Co., and sandblast ten tons of castings for an electrical apparatus a week.

The accompanying photograph reveals a workman with a wheelbarrow full of castings with the rather dubious inspiration of tombstones in the background, which doubtless proclaim: "Rest in Peace."

Rolling to Victory



Our mills are working to capacity rolling "BERALOY 25" (beryllium-copper), "TOPHET" (nickel-chrome), and "CUPRON" (copper-nickel) ribbon and strip for vital war applications — **so vital** we know that we are actually "ROLLING TO VICTORY".

Consult us on your requirements for hot and cold rolled special alloys in rod, wire, ribbon, and strip.

WILBUR B. DRIVER CO.
NEWARK, NEW JERSEY

Manganese Alloy for Industrial Controls

Chace manganese alloy No. 772, primarily for instruments and industrial controls, is made by the *W. M. Chace Co.*, 1600 Beard Ave., Detroit. There are four main useful characteristics: (1) high electrical resistivity, (2) high thermal expansion rate, (3) high vibration damping constant, and (4) low thermal conductivity combined with good ductility and high tensile strength.

Over 70 per cent of this base alloy is manganese. The electrical resistance is 1050 ohms per circular mill foot. The thermal expansion rate is twice as high as for steel. The vibration damping constant is 2.3 per cent as against 0.01 for hardened steel. Thermal conductivity is only 2 per cent of copper.

The alloy is suited for such low temperature resistor applications as rheostats, auxiliary heaters for circuit breakers and electrically heated expansion elements. It can be fabricated readily by rolling, drawing and machining.

● Fireproofing of wood for industrial and other uses is done by impregnation with chemicals under vacuum-pressure by the following methods: (1) diluting the oxygen to form a non-flammable gas, (2) forming a fused layer, which prevents the entrance of air, (3) lowering the temperature of wood by releasing water of crystallization, and (4) by the formation of a protective layer of char, which is hard and clinker like and has high insulating properties. So states the *Protexol Corp.*, Kenilworth, N. J., which operates a 49 year old process of fireproofing.

Fine Brushes Remove Copper Insulation

A rotary wire brush, used in construction of radios and sensitive electrical instruments, is made of 242,144 mild steel wires, .0025 in. thick, "soft as velvet though each point is sharp as a needle." It is manufactured by the *Osborn Mfg. Co.*, Cleveland.

Two of these cylinders, mounted parallel and rotating on spindles at 3,450 r.p.m., trim very hard-baked insulation off exceptionally fine copper wire. It removes insulation without marring the copper.

ANOTHER BATTERY OF DREVER CAR TYPE FURNACES

Five Drever oil fired annealing and drawing furnaces which will take their place in peace-time production just as they are now being used for economical heat treatment of war materials.

This battery of rugged furnaces embodies many advanced engineering principles which are standard practice in Drever furnace design: automatic temperature control—motor-driven car and door—transfer car and pit—dependable sand seals for furnace and car—door sealed top and bottom—all safety features—burners, heating chamber, and accessories of the highest quality and of proper rating for the efficiency required.

Drever Furnaces are engineered to suit the individual needs of the plants in which they are installed.

EXPERIENCE POINTS TO THE DREVER CO

750 E. VENANGO ST., PHILADELPHIA, PA.

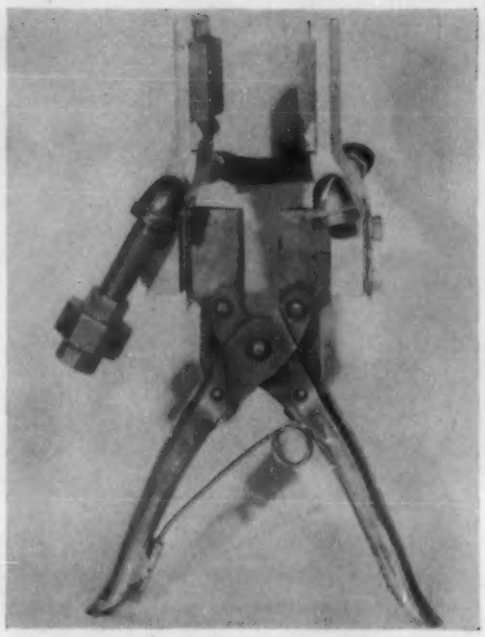
Water-Cooled Tongs for Silver Brazing

A pair of water-cooled tongs for silver brazing has been built up from a pair of 8-in. parallel flat nose pliers by *General Electric Co.,* Schenectady, N. Y. The tongs are used as carbon holders in the incandescent carbon process of silver brazing, and are cool, light and efficient.

To make the tongs, steel blocks are first welded onto the plier jaws to give them an outside width of 1½ in. when closed. The blocks are drilled and tapped for ⅜ in. bolts. Bar copper is bent to fit the clearances required for the job to be handled, and the tips are cut to hold small blocks of carbon.

The bars are drilled and tapped to accommodate ¼ in. pipe fittings by which water-cooled power leads are attached. A rubber hose jumper forms a water connection between the jaws. Additional water carriers may be drilled the entire length of the bars.

Mica sheets and bushings form insulation between parts and pliers. A pronged



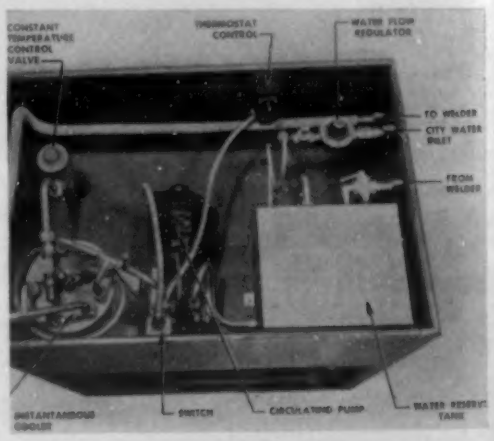
spring of wire facilitates opening the jaws when the braze is completed.

● A new flux for gas welding of magnesium is announced by *Park Stewart,* 1045 Carbis St., Worthington, Pa., and is called "Mag-na-Flo" flux. It is suitable for all magnesium alloys, whether sheet or extrusions. It is mixed into a thin paste by pouring the flux into water while stirring. One paints the metal to be welded by a brush dipped in the flux.

Spot Welder Cooler

In accordance with the claim that 40 deg. F. is the ideal coolant temperature for tips in spot welding aluminum, the 580-WC spot welder cooler has been developed by the *Temprite Products Corp.,* 47 Piquette Ave., Detroit. Advantages claimed are: Longer life of welding tips, consistent uniformity of weld, and increased production per welder.

The unit operates as a water circulating system and can operate one, two or three separate spot welders, depending on the



maximum heat load of the welders and the resistance to flow through the welder water circuit.

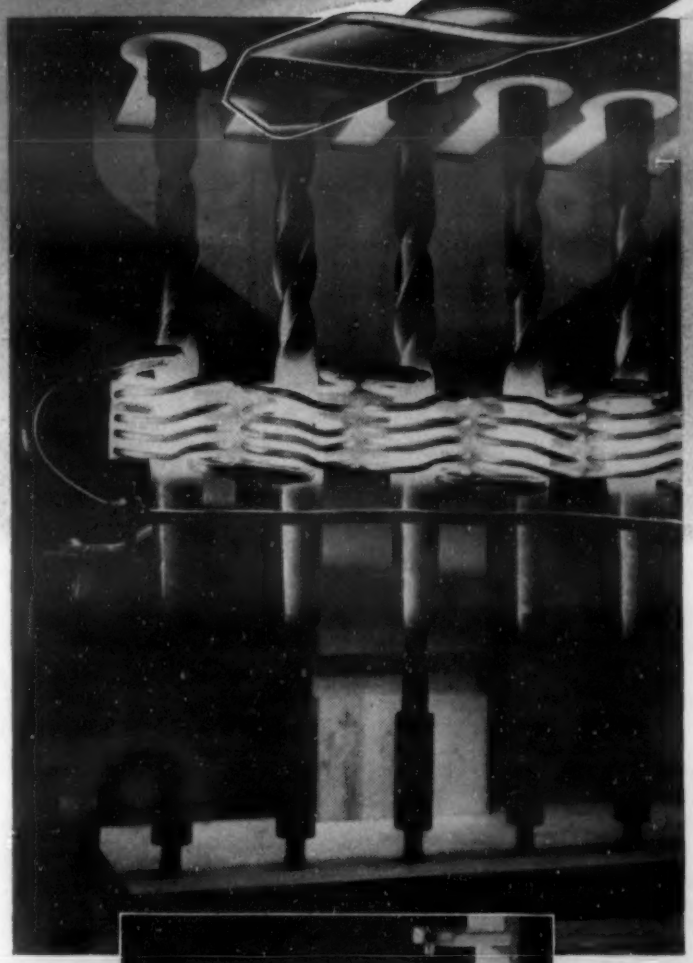
It is equipped with the instantaneous water cooler and accessories, including a constant temperature control valve, a 1 h.p. refrigeration condensing unit and a ½ h.p. water circulating pump.

The system can circulate 120 gal. of water per hr. against a spot welder pressure drop of 100 lbs. gage.

for
ATMOS
GAS
from 1,000 to 30,000 c. f. h.
the Kemp Atmos Gas Producer is designed to fit the job including the auxiliaries most efficient in producing the desired results for the specific material being treated. Kemp experience will be helpful in meeting your bright annealing problem. It is yours on request. Address The C. M. Kemp Mfg. Co., 405 E. Oliver St., Baltimore, Md.
ARMY E NAVY
The Army-Navy E flag, awarded "for high achievement in the production of materials of war".
KEMP of BALTIMORE

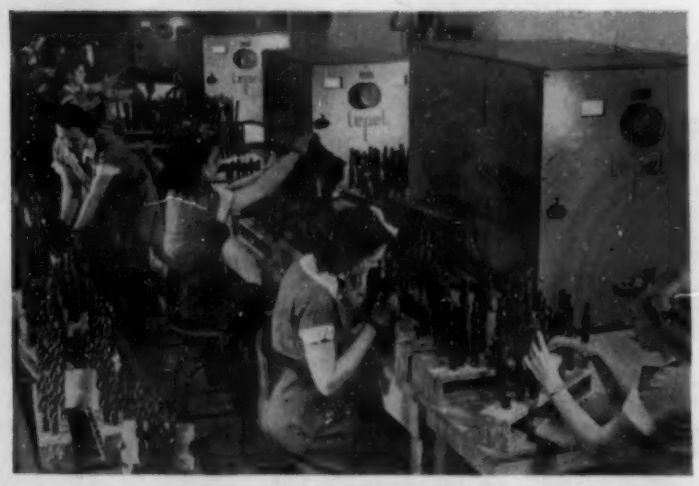
New Republic Method

FOR MAKING TWIST DRILLS



USING Lepel HIGH FREQUENCY INDUCTION HEATING

By replacing conventional welding methods with modern high frequency induction brazing, the Republic Drill & Tool Company, Chicago, Ill., have made an outstanding contribution to the efficient manufacture of twist drills. Photo at left shows the new Republic gang-brazing set-up for joining shanks and high speed drill barrels, on the larger size drills, by LEPEL induction heating. A special high temperature compound is used wherein the brazing action occurs at 1800° F., thus eliminating all danger of separation in high temperature service. This development permits high production machining of the shanks, and heat treatment of the fluted sections, *before* rather than after assembly. The advantages, the economy, the added efficiency . . . all are obvious.



Photos to left show gang-brazing department at Republic, with battery of compact, efficient LEPEL induction heating units; also, female operator quickly brazing a shank to one of the 'long ones' at Republic.

Whether your production problem involves BRAZING, SOLDERING, LOCALIZED HARDENING, ANNEALING, BOMBARDING or MELTING, LEPEL High Frequency Induction Heating in all probability can *greatly expand your output—reduce rejects to a negligible quantity—solve your skilled worker problem*—and *cut costs appreciably*. LEPEL Engineers will gladly and promptly submit facts and figures—based on your own work—if you will acquaint them with your problems. Write or wire today.

Lepel HIGH FREQUENCY LABORATORIES, INC.

39 West 60th Street, New York, N. Y.

PIONEERS IN INDUCTION HEATING

Sets of 81 Gage Blocks

A standard set of 81 Doall master gage blocks is being produced by the *Savage Tool Co.*, Minneapolis, Minn. The blocks range in length from .050 in. to 4.00 in., and are produced in three grades: AA (accuracy, .000002 in.); A (.000004 in.); B (.000008 in.) The blocks can be wrung together in combination to secure any dimension in steps of .0001 in. from .1000 in. to 12.00 in.

Precision optical measuring instruments are used to check the accuracy of every gage block produced, the same equipment being available to users for rechecking their gage blocks after considerable use. Those worn beyond tolerance will be replaced.

As the makers point out, the first World War was fought in thousandths of an inch, while the present war, in tenths of a thousandth.

Brushes Ban Fissures and Failures

"Fires in airplanes in flight are usually caused, aside from enemy incendiary bullets, by fractures of the fuel lines — at their ends where they have been flared to hold on pipe connections," states R. O. Peterson, technical director of the *Osborn Mfg. Co.*, Cleveland.

"Looking at these ends under the microscope, we could see fissures along the sharp edges of the tubing before it had been flared," he continues. "When the ends of the tubing are flared, the fissures widen. A sharp edge, even of the finest razor blade, is never continuous. Tiny nicks can be seen under the microscope. The bottoms of these nicks are points of stress concentration — points of weakness where fractures start."

Osborn has perfected an end brush of fine wire rotating on a chuck whereby sharp corners on tubing are rounded by momentary insertion. Where a high degree of precision is needed, the brushes smooth out surfaces to an accuracy of four- to eight-millionths of an inch. Power brushing can do the work at least 100 per cent faster than by hand.

● A new line of Steelgrip Rigid-arm gear and wheel pullers has been added by *Armstrong-Bray & Co.*, 5364-78 Northwest Highway, Chicago. They will take care of a wide range of jobs covering factory work, tank, tractor, truck and farm maintenance.

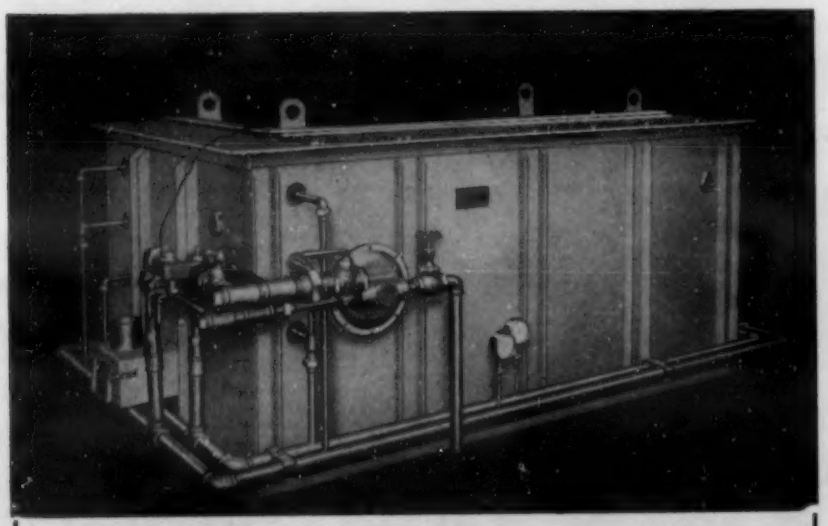
Surface Coated Abrasive Belts

Newly developed equipment incorporates the use of surface coated abrasive belts for faster and better finishing. It consists

of the use of a backstand idler unit, utilizing a newly perfected segment face contact wheel and belts. The shop's present lathe or set-up equipment can be used, or a complete backstand idler unit acquired for this work.

There are three types of segment face contact wheels. There is provided a hard, flat surface for driving the belt but with a soft center so that irregular shaped pieces can be finished.

They are made by the *Minnesota Mining & Mfg. Co.*, St. Paul, Minn.



RECTANGULAR POT FURNACES

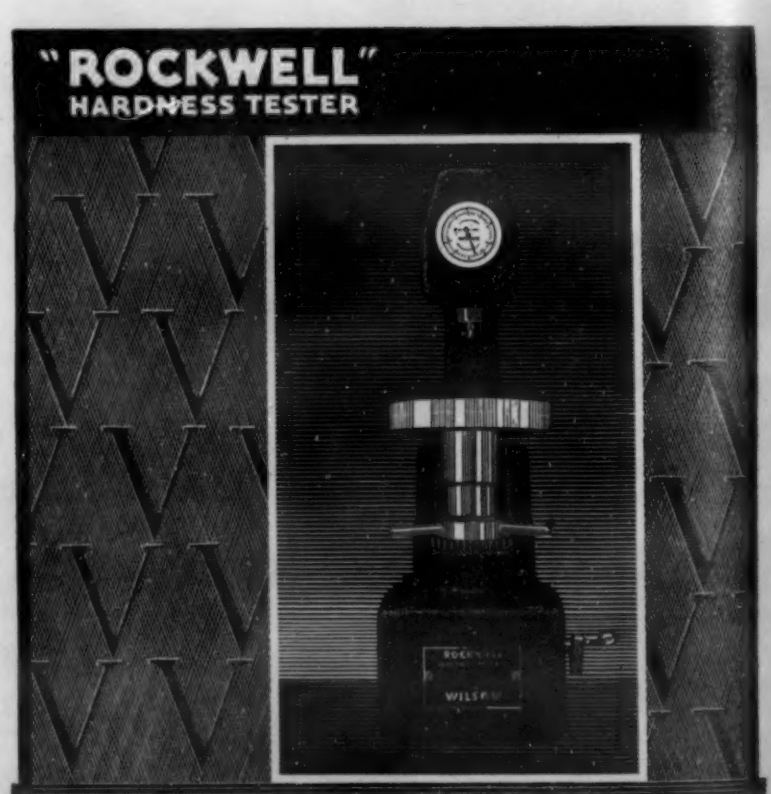
Especially suited for heat treatment of aluminum alloys, strip brass annealing, tinning, lead coating, etc., these furnaces are also used for tempering with oil, salt, or lead.

Another application is in the continuous hardening and tempering of wire and strip, including lead quenching at an elevated temperature.

Uniformity of work and long life of pots is achieved through the use of many small burners distributing the heat evenly and without impingement upon the pot.

Write for full information including details of your problem.

American Gas Furnace Co.
Elizabeth, New Jersey



ITS REPUTATION FOR BOTH INITIAL AND ENDURING ACCURACY HAS BEEN GROWING CONSTANTLY FOR A FIFTH OF A CENTURY

WILSON
CONCORD AVE NEW YORK MECHANICAL INSTRUMENT CO. INC.

PLURAMELT...YOUNGSTER WITH A FUTURE

TODAY, Pluramelt products are entirely allocated for essential purposes. In fabricated form, they're serving in mess trays aboard ship—in field ranges—in kitchen and hospital equipment for the services—in the manufacture of synthetic rubber, high-octane gas, explosives, etc. The list includes both the single and double stainless-armored types.

In each case, of course, Pluramelt is used instead of *solid* stainless steel. The chief reason, therefore, is the very important matter of conservation. Pluramelt saves 60% to 80% of the vital chromium and nickel that solid stainless would consume for the same job.

But there are other prime considerations. Pluramelt in general fabricates easier than solid stainless steel. And, under any conditions of fabrication and subsequent service, it does not—*cannot*—come apart. Pluramelt is unique—a controlled composite steel with an *intermelted* bond that cannot be separated.

Do you want to know more about this stainless-armored steel that is so sure to bulk large in the peacetime manufacturing of the future? A brand new booklet on the subject of *"Pluramelt Stainless-Armored Steels,,* is now ready • Write for *your* copy. ADDRESS DEPT. MA.

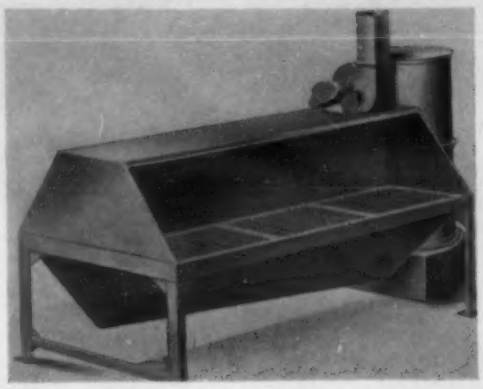
Allegheny Ludlum
STEEL CORPORATION
GENERAL OFFICE: BRACKENRIDGE, PENNA.

A-8676 . . . W & D

Dust Collectors for Magnesium Operations

The Multi-Wash dust collection system, made by the *Claude B. Schneible Co.*, 3955 Lawrence Ave., Chicago, employs a high flash point mineral oil as the collecting medium in grinding, polishing and other operations involving magnesium dust. The heavier particles are submerged in the oil bath and carried away to the settling tank, while the lighter, or float dust particles, are collected in the Multi-Wash unit for deposit in the tank.

Another advantage is that all aluminum-magnesium dust is salvaged, which is a by-product of the original function of preventing fire and explosions.

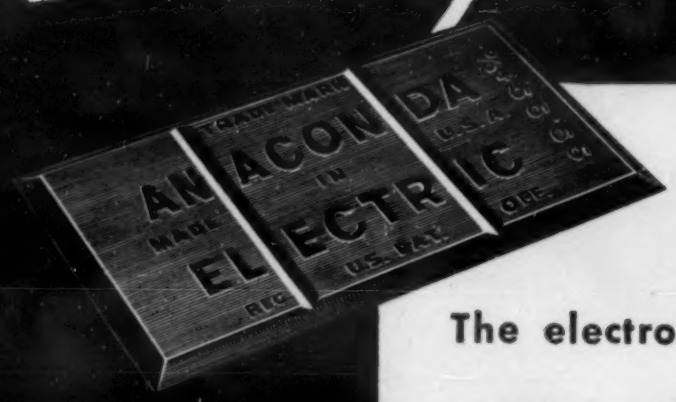


Another related product is a downdraft ventilating bench, such as shown in the accompanying photograph. They have hard wood gratings. Canopies and end sheets guard against side drafts and provide maximum ventilating efficiency with a minimum of air volume. The bottom of the V-shaped hopper slopes toward the exhaust outlet, and may be flushed with oil to carry heavier particles to the settling tank.

● Requests for a color code to identify machine lubricants have been tendered to the *American Standards Assn.* by the *War Production Board* and *National Machine Tool Builders Assn.* Present inexperienced workers make such a standard a necessity. The oil cap on the spindle of a grinding machine might be painted red, the same color to mark the container holding spindle oil. One can imagine the damage that could occur should the worker put grease into the bearing where fine oil was needed.

ANACONDA

Electrolytic ZINC



SPECIAL HIGH GRADE 99.99+% pure

The electrolytic refining process, originally conceived for the treatment of complex lead-zinc ores, consistently produces zinc of the highest purity. 42282

ANACONDA

ANACONDA SALES COMPANY

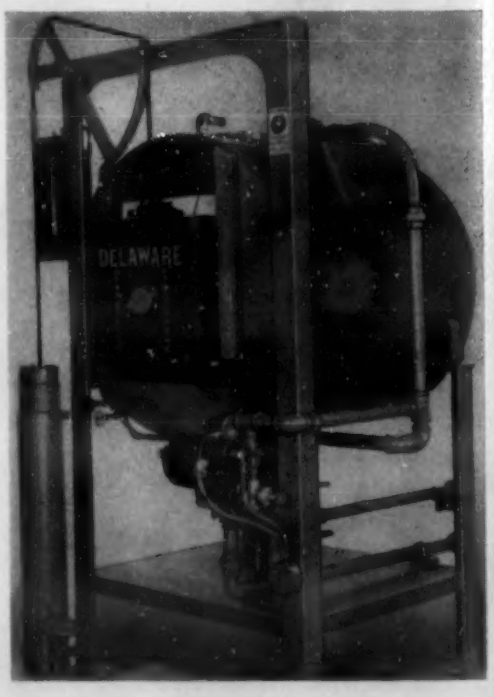
25 Broadway, New York

Subsidiary of Anaconda Copper Mining Co.

Heat Treat Furnace 1000 to 2500 Deg. F.

For heat treating or tipping tool, alloy, high speed and molybdenum steels at 1000 to 2500 deg. F., there has been brought upon the market the Delaware controlled atmosphere furnace, made by the *Delaware Tool Steel Corp.*, 3400 Market St., Wilmington, Del. A unique tangential firing technique provides absolute temperature uniformity throughout the operating area, with only a short interval until the desired heat is attained.

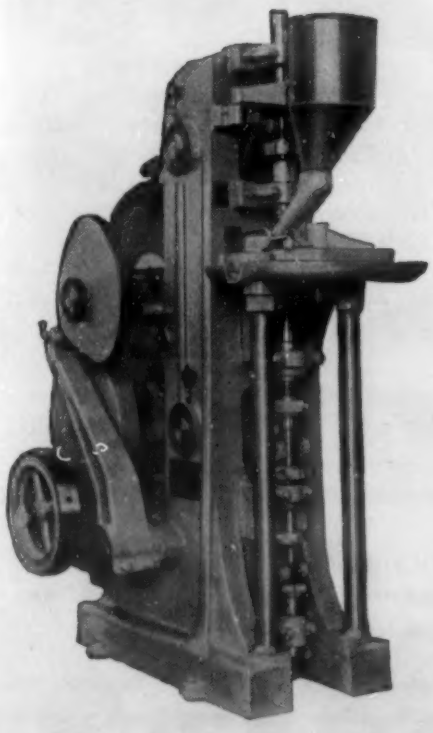
Because of the 8½-in. insulation, heat losses are so low one can lay hands on the outside shell while the furnace operates at 2250 deg. F. The furnace is shipped completely piped for connection to low-pressure air and artificial propane, butane or natural gas, with atmosphere manometer and easily adjustable gas-air valve for hand control.



Standard accessories include proportioning temperature control, heavy duty valve motor, strip chart recording potentiometer and platinum thermocouple.

Pressed from Powdered Metals

STOKES PRESSES
Save Labor, Time, Materials



These parts are typical of hundreds being pressed from powdered metals . . . ordnance components, iron gears, porous bearings, parts for electrical assemblies, radio, communications systems, Alnico magnets, hard carbide tool bits, etc. . . . on Stokes Automatic Presses.

Stokes pioneered the development of this type of press . . . equipment which is the result of 25 years of research . . . and is constantly engineering new models in capacities and types to meet ever-widening applications.

Let us make recommendations on methods, equipment and applications . . . consult with you on specific pressing problems. Our laboratory facilities are available for experimental work. Write for complete 48-page illustrated catalog.

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F.J.Stokes AUTOMATIC TABLETTING EQUIPMENT FJS Est. 1895

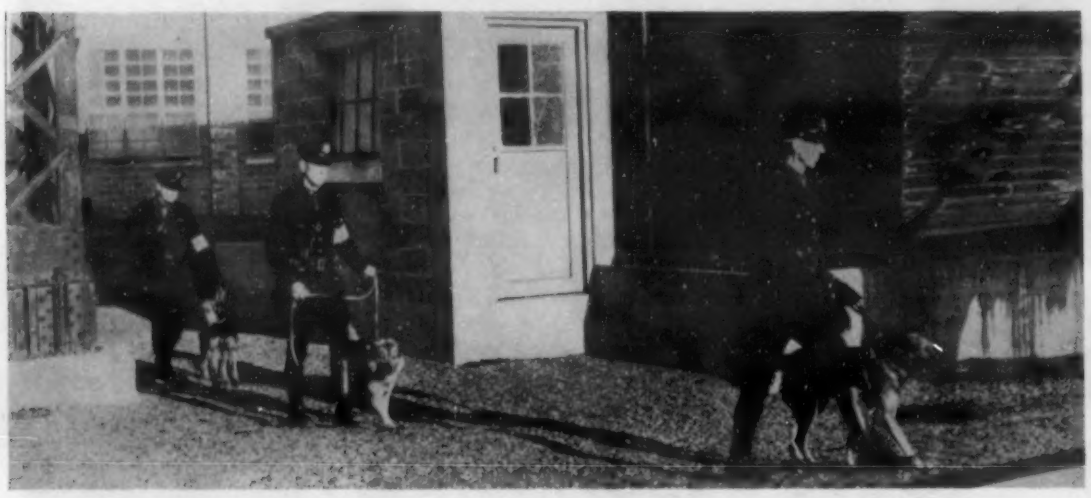
News of Men, Societies, Meetings and Companies

Plants and Slants

Night patrols at the Pennsylvania tank plant of the *American Car & Foundry Co.* have dogged perseverance in tracking down possible saboteurs and others who may be around the plant for no good purpose.

The dogs make the rounds nightly with the guards. They will obey the command of the guard instantly and attack furiously when ordered. They are especially adept in searching dark corners and areas where piles of material afford lurking places for trespassers.

Strict army discipline is maintained over the canines so that they will not become soft. The dogs spend daytimes sleeping and resting, though it was difficult at first to get them to revise their sleeping habits



and periods. The dogs were given to the Army by patriotic citizens. The first selectees are "Logi," an Elkhound; "Fritz," a German Shepherd, and "Squeegee," an Airedale.

Aluminum castings of higher tensile strength, greater elongation and finer finish, made by a special permanent mold process, are being turned out by the *Majestic Aluminum Co.,* Huntington, Ind., which succeeds the Majestic Co., that city. Because of the fine finish, little machining is necessary, the makers claim. The company now works 100 per cent on aircraft work.

Lack of space forbids mention of all plants in the metal industries that have been awarded the Army-Navy "E." However, when there is some fact or circumstance out of the ordinary, it becomes "news." Thus, the Chicago plant of *Crane Co.* was awarded it, not because of some converted product, but for meeting vast wartime demands for its regular products: Valves, fittings and piping accessories. Donald M. Nelson stated recently that valves are one of the chief bottlenecks.

The feature of the "E" ceremony of the *Macwhyte Co.,* Kenosha, Wis., was the recognition of the part played by labor, with management stepping into the background. In accepting the "E" award on behalf of the *Dow Chemical Co.,* Midland, Mich., Dr. Willard H. Dow brought out some interesting facts in his speech. He said that more than 2000 chemicals are needed to build an airplane; more than 200, for a tank. He said the Germans may still use gas. The Italians won their war against the Ethiopians with gas, and the "Japs have used it hundreds of times on the defenseless Chinese."

Kelly-O'Leary Steel Works, 5757 W. 65th St., Chicago, is the new name for the former Arthur J. O'Leary and Son Co. The original company was one of the early forge shops in Chicago, established as Smith and O'Leary in 1874. The new name is the fourth corporate name for the company.

The *Joshua Hendy Iron Works,* Sunnyvale, Calif., has acquired the Pomona Pump Co., its subsidiary, Westco Div., and the Crocker-Wheeler Electric Mfg. Co. The Hendy works was established in 1856 and was built originally to turn out gold mining equipment. Now comes out marine engines, steam turbines and various ship equipment.

The first electrode plant on the Pacific Coast, the *National Cylinder Gas Co.,* has been put into operation. Millions of pounds of "Sureweld" protected-arc electrodes have already been produced there. Sales offices are at 4950 Santa Fe Ave., Los Angeles and 326 Howard St., San Francisco.

American-Marietta Co., Chicago, has acquired the Ferbert-Shorndorfer Co., Cleveland. The purchasing company specializes in industrial finishes and maintenance paints for industry.

Carpenter Steel Co., Reading, Pa., has moved their St. Louis district warehouse to 712 Cass Ave., St. Louis.

The American Propeller Corp., Toledo, Ohio, is increasing plant capacity by 50 per cent, thereby becoming the largest hollow steel propeller blade manufacturing plant in the country, they say.

Despatch Oven Co. has moved its southern offices to the Martin Building in

. . . if you're troubled with chattering machine tools or hot bearings and gears

"STURACO"
★★★★
Extreme Pressure ("E P") Machinery Oils and Greases

USE "STURACO" — it has a technically accepted load carrying capacity of over 300% more than ordinary lubricants.

To eliminate sticking ways — to cool hot spindle bearings and gear heads — put "STURACO" on the job. Results from this unusual principle of lubrication have been astonishing. If you have a tough problem write us today.

For All Cutting Fluid Problems

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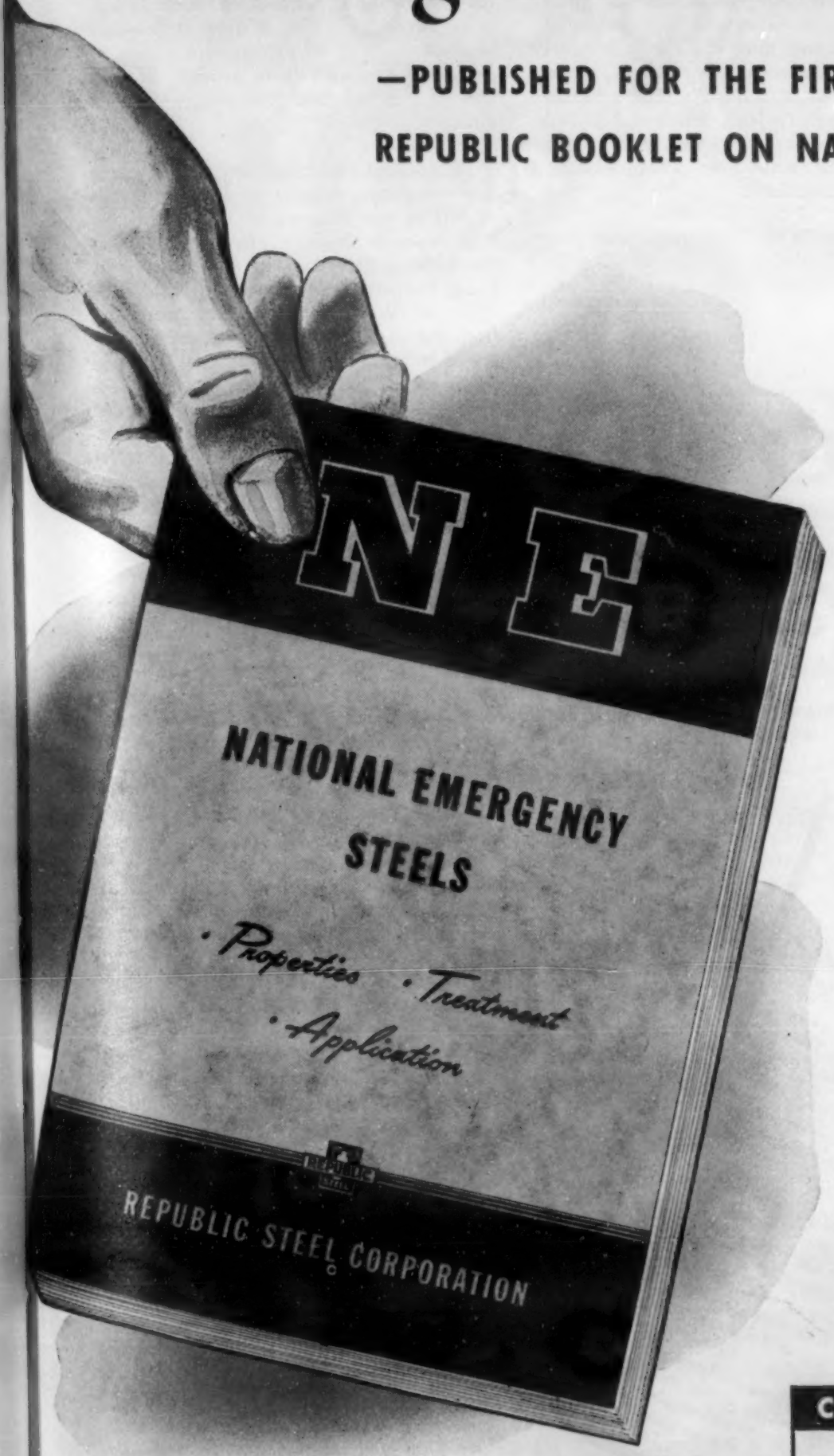
Warehouses in all Principal Metal Working Centers

New, Original Data on NE Steels

—PUBLISHED FOR THE FIRST TIME IN THIS HELPFUL REPUBLIC BOOKLET ON NATIONAL EMERGENCY STEELS



Here's just what you've been looking for—70 pages of valuable *new* data on the properties, treatment and application of the NE Steels—in handy, usable book form.

Much of the material in this book—charts, tables and specifications—has been prepared from original research conducted by Republic metallurgists. There's an explanation of the end quench hardenability test and its importance, too.

Republic—long a leader in alloy steel production—was an important factor in the development of the NE series. Now, Republic offers this helpful book on NE Steels as its contribution to more efficient, more productive, faster war fabrication wherever these alloy-conserving steels are applied.

If you have been using alloy steels, you probably are now using NE Steels—or will in the near future. You should have a copy of this book at your finger tips. You'll be surprised at the vast amount of data it will bring you. Printing is now under way, and the book will soon be ready for distribution to *engineers, metallurgists and production executives.* Send your request now to insure early delivery.

REPUBLIC STEEL CORPORATION

Alloy Steel Division

Sales Offices • Massillon, Ohio

GENERAL OFFICES • • CLEVELAND, OHIO

Berger Manufacturing Division • Culvert Division
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Republic Steel Corporation, Department MA
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Please send me a copy of your new NE Steels Handbook, which I understand will be off the press shortly.

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Company _____

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—REPUBLIC—

Alloy STEELS

Would you like data on other Republic products—Enduro Stainless Steel, Sheets, Plates, Upson Bolts, Nuts and Rivets, Hot Rolled and Cold Drawn Bars, Electrunite Aircraft and Mechanical Tubing? Write us.

Birmingham, which will be under the supervision of Wm. H. Riddell.

Pig iron production at the Granite City, Ill. plant, operated by *Koppers United Co.*, was doubled when the second of two rebuilt furnaces was lighted.

Briefs on Associations, Promotions, Education

Its first award program in the field of undergraduate engineering study has been announced by the James F. Lincoln Arc Welding Foundation. Its object: "To encourage engineering students to study arc welded construction so that their imagination, ability and vision may be given an opportunity to extend knowledge of this method and thus aid the war effort and the economic reconstruction in the peace which is to follow." The program offers $5,000 in student awards and $1,750 in scholarships for the departments of the institutions in which the award-winning students are registered.

The Perkin Medal for 1943 was presented last month to Dr. Robert E. Wilson, president, Pan American Petroleum and Transport Co., at the joint meeting of five societies in the chemical fields. The medal is awarded annually by the American section of the Society of Chemical Industry for outstanding work in applied chemistry. Dr. Wilson is inventor or co-inventor of 90 patents in a variety of fields and an authority on patents. He has studied flow of fluids, oiliness, corrosion, etc.

Methods of obtaining new and stronger tin-base alloys suitable as bearing metals is part of the program of research of the Tin Research Institute, International Tin Research & Development Council, Fraser Road, Greenford, Middlesex, England. The effect on hardness, produced by quenching from the highest practical temperature followed by prolonged tempering at 212 and 284 deg. F. has been examined for 80 tin-base alloys containing 4 to 14 per cent antimony and 0 to 10 per cent cadmium. These alloys can be hardened by heat treatment and maintain a useful degree of improvement for at least 1,000 hrs. at 212 to 284 deg. F. The best alloys range: Antimony, 9 to 10 per cent; cadmium, 1 to 1½ per cent; balance, tin. Reprints of a paper containing this data are free.

A new educational motion picture on "die casting" has been made available by the New Jersey Zinc Co., New York. It is in a 3-reel film, and designed to be educational and engineering rather than selling. Though the sponsor is a zinc company, other metals are given liberal treatment. The movie producer was Paul Hance Productions, Inc.

The following officers and directors of the American Foundrymen's Association have been placed in nomination for 1943, and will take office following the annual conference at St. Louis, April 28-30:

President: Lee C. Wilson, general manager, Reading Steel Castings Div., American Chain & Cable Co., Reading, Pa.; *Vice-president:* Ralph J. Teetor, president, Cadillac Malleable Iron Co., Cadillac, Mich.

Directors for three years: D. P. Forbes, president, Gunite Foundries, Inc., Rockford, Ill.; Roy M. Jacobs, president, Standard Brass Works, Milwaukee; Max Kuniansky, general manager, Lynchburg Foundry Co., Lynchburg, Va.; Harry Reitinger, resident manager, U. S. Pipe & Foundry Co., Burlington, N. J.; W. B. Wallis, president, Pittsburgh Lectromelt Furnace Co., Pittsburgh.

America's engineering skill, as well as its raw materials, should be available to many countries after the war as an extension of the Atlantic Charter, stated C. A. Powel recently, engineering executive of the Westinghouse Electric & Mfg. Co., before the Rochester section of the American Institute of Electrical Engineers. "The easier it is made for the millions outside the United States to live decently, the less they are likely to want to fight every 25 years. By helping the smaller and poorer countries to improve their industrial facilities, we help raise their standards of living, which, in turn, makes our own standard of living more secure," Mr. Powel continued.

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NON-FERROUS METALS

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1— Oil — Pressure on delivery line to burner should be set for 15 lbs. minimum — 30 lbs. maximum.

2— Air — Burner shall operate with air pressure of 16 oz.

3— Lighting burner (from a cold start). Turn on motors on both oil pump and blower; place lighted torch immediately at the front of burner tip. Now open air blast gate to deliver about one-third of capacity; then admit oil gradually to the burner. Hold furnace at this low rate of firing until a hot spot has been established. Then turn blast gate valve to full open position and increase the oil input until the desired flame quality is attained.

4— Lighting Burner (when furnace is hot). Throw blast gate to wide open position; then turn on oil in sufficient quantity to produce desired flame quality.

5— Suggestions — It is not good practice to attempt to control oil-air ratios by use of air valve. The burners supplied with Fisher Furnaces are designed to deliver the proper oil input with the blast gate fully opened. Control flame quality with oil valve only. To avoid the use of air in excess of that required to maintain a neutral atmosphere, admit the oil in a quantity to produce a smoky tail on the flame, then reduce the delivery slightly until the smoky condition disappears. To prevent coking within the burner body and to keep the burner clean, after each time the oil is shut off, sweep out the oil that collects within the burner by opening the blast gate for a few seconds. A sudden flash will be noted; after the flash, close the air gate.

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News of Metallurgical Engineers

John H. Romann, chief metallurgist, Tube-Turns Div., Louisville, Ky., makers of welding fitting and special forgings, has been appointed chairman of a committee to investigate low temperature properties of metals. The research is being carried on by the War Metallurgy Committee of the National Research Council, Washington.

Albert C. Delmont has been made research director of the research and laboratory departments of the Douglas T. Sterling Co., Stamford, Conn. He will specialize in post-war planning. He was formerly material engineer with the General Chemical Co.

Raymond M. Dennis has been appointed assistant to the president of By-Products Steel Corp., Coatesville, Pa. He will have charge of the staff and general administrative work for the corporation, which is a subsidiary of the Lukens Steel Co. He had been general manager of the flanging department at Lukens.

Leo Edelson, development engineer, Handy & Harman, has become executive vice-president, Induction Heating Corp., 389 Lafayette St., New York.

Harry G. Smith has been named operations manager, Aircraft Parts Div., Reynolds Metal Co., 2500 S. Third St., Louisville, Ky. He will superintend the opening and operation of five additional plant buildings, leased by Reynolds. In past years he has specialized in the production of aluminum items, as well as fabricated brass, steel and screw machine products.

J. H. Cooper has been made chief, Resistance Welding Section, General Industrial Equipment Div., WPB, Washington. He has been given a leave of absence by the Taylor-Winfield Corp., Warren, Ohio, where he has been welding engineer.

Carl G. Preis has been elected vice-president of the American Can Co., in charge of engineering. He was formerly chief engineer. He is also vice-president and general manager of the Amertorp Corp.

B. De Lorenzo has become manager of the heat transfer department, Brown Fintube Co., Elyria, Ohio. Since 1936 he has been design engineer for Foster Wheeler Corp., New York, in the oil division, specializing on heat transfers and flows of fluids.

Ralph C. Stuart has become manager of manufacturing and engineering for the Westinghouse Lamp Div., Bloomfield, N. J. He was manager of the West plant of the Canadian Westinghouse Co., Hamilton, Ont. from 1930 until January, 1943.

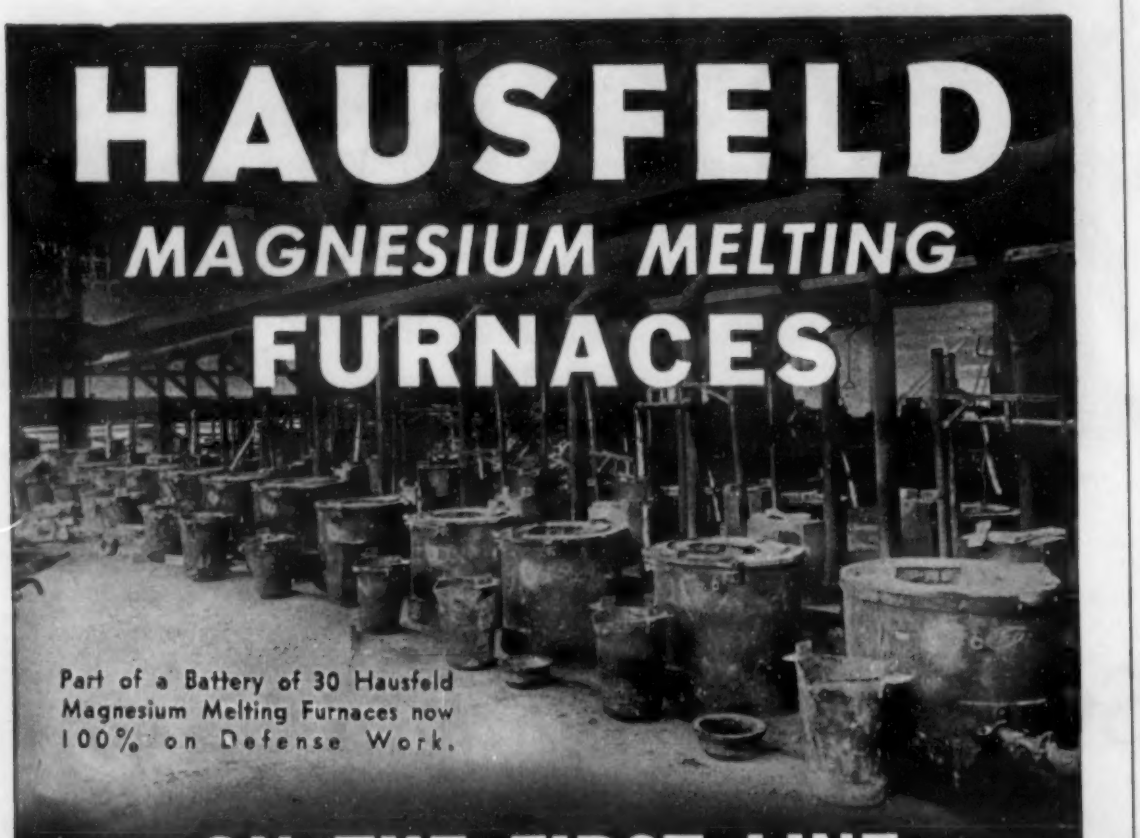
John D. Tyson has been made manager of sales and metallurgy, Standard Steel Works Div., Baldwin Locomotive Works, and will be located at Burnham, Pa. instead of Eddystone, the former headquarters. He has been chief metallurgist with Standard since 1930.

J. D. Shaw has joined Aircraft Parts Development Corp., Summit, N. J., as chief powder metallurgist. He was formerly research and production engineer with Metals Disintegrating Co.

David W. Hopkins has been elected vice-president, R-S Products Corp., Wayne Junction, Philadelphia, and will continue in charge of the company's valve division. He has taken post-graduate work in aeronautical engineering at Massachusetts Institute of Technology.

John S. Morris has been appointed methods engineer for By-Products Steel Corp., Coatesville, Pa., subsidiary of Lukens Steel Co. He has worked with the Bethlehem and Alan Wood Steel Companies.

Glenn W. Shetler, production manager, Crucible Steel Co., Syracuse, N. Y., has become associated with Barium Stainless Steel Corp., Canton, Ohio, as general manager. He has been in the steel business since 1916, when he joined the United Steel Co. in Canton, which is now part of Republic Steel Corp.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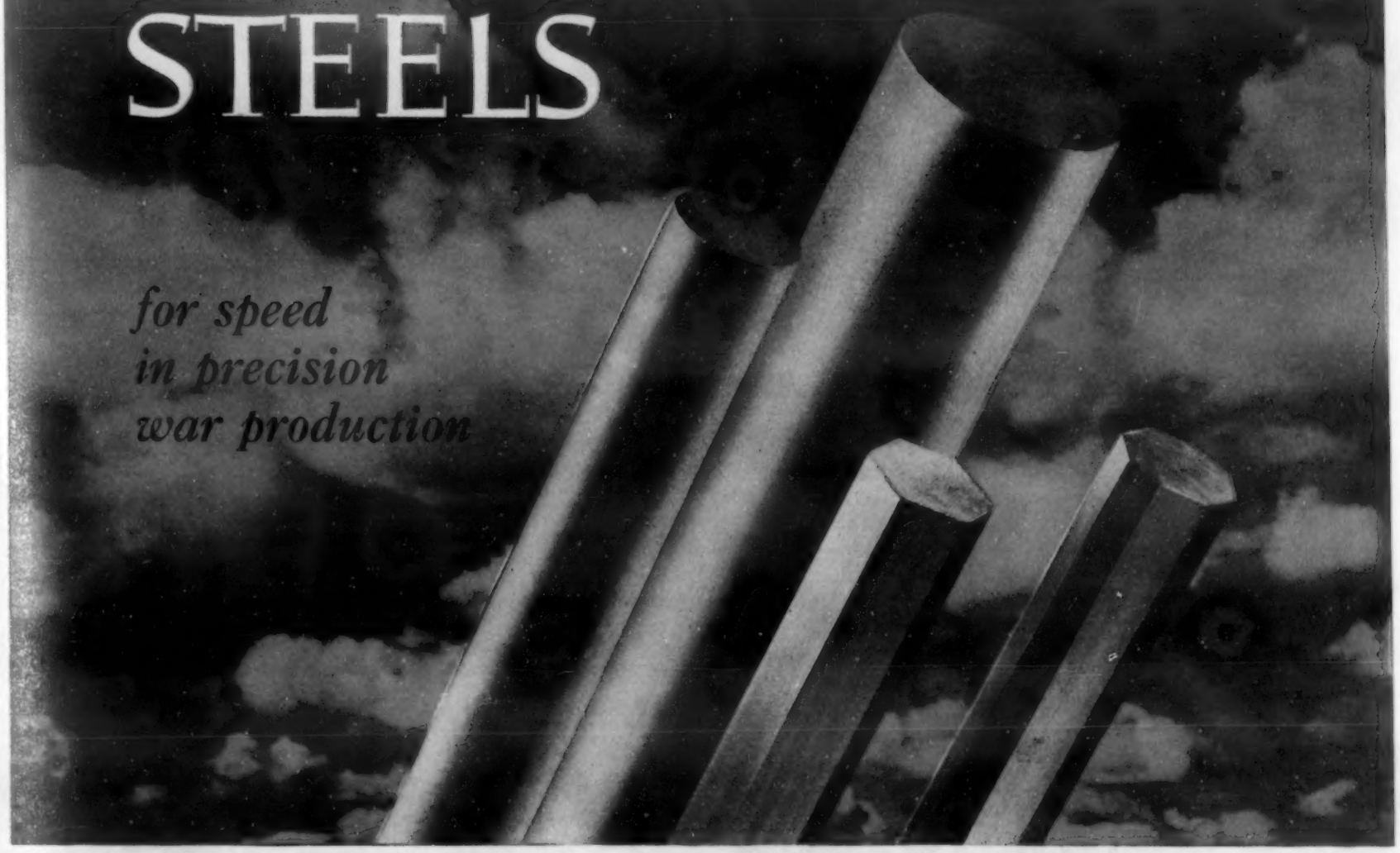

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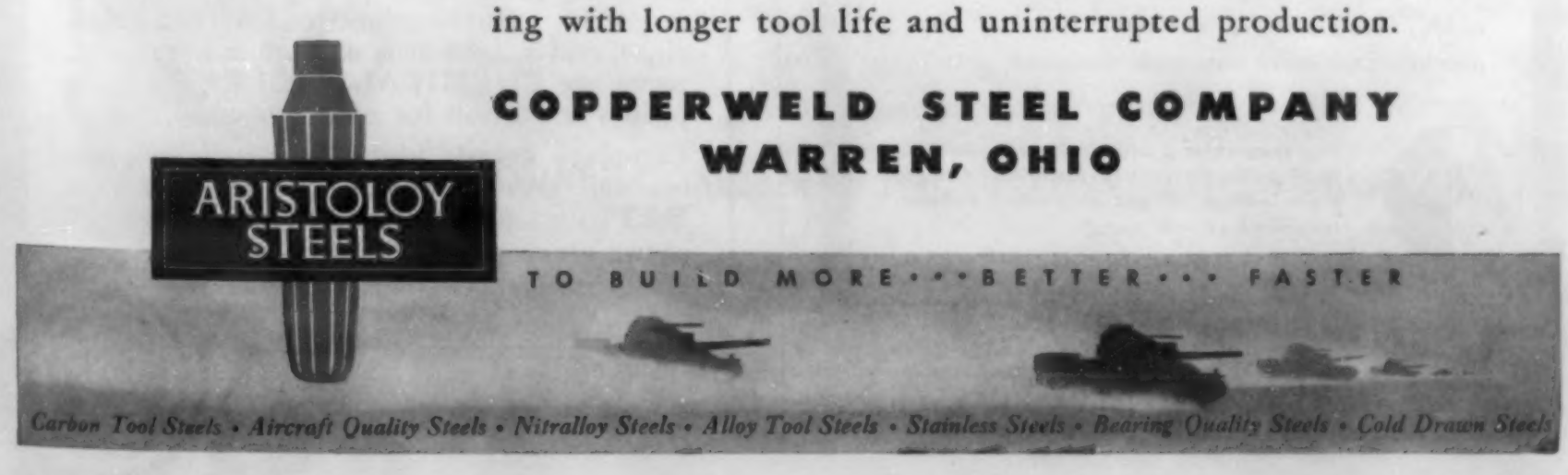
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A.I.M.E. February Convention

As has been the custom for some years, the annual convention of the American Institute of Mining and Metallurgical Engineers is being held at the Engineering Societies Building in New York, Feb. 15 to 18.

Of special interest to readers of METALS AND ALLOYS are the activities of the two metal divisions — The Iron and Steel Division and The Institute of Metals Division.

Sessions on Iron and Steel

On the program of the Iron and Steel Division, at least one session is being devoted to steelmaking, the subjects varying from the electric conductivity of molten blast furnace slags, and the rapid analysis of oxygen in molten steels, to kinetics of the oxygen-carbon reaction and so on. There are three important papers at other sessions on austenite transformation as well as one on a study of carbides in low chromium-molybdenum steel.

An important paper being presented at one of the sessions comes from the Naval Research Laboratory dealing with the effect of arsenic, columbium, cobalt, copper, nitrogen, antimony, tin, titanium and zirconium on hardenability.

The twentieth annual Howe Memorial Lecture is being delivered by Leo F. Reinartz, manager, Middletown District, American Rolling Mill Co. This lecture traces the growth of research in the steel industry and its effect upon the general improvement of quality that has occurred over the past 40 yrs. with special attention to recent developments.

Non-Ferrous Paper

There is a wide diversity of interest in the non-ferrous papers being presented at the sessions of the Institute of Metals Division. There are two papers in the field of powder metallurgy — on copper-tin compacts and on the formation of aluminum and aluminum alloys by powder metallurgy. Other papers being presented and discussed include the embrittlement of silver by hydrogen and oxygen, and the effect of antimony on 70-30 brass. There are 3 papers on the light alloy field, and 4 papers deal with physical metallurgy.

A one-day symposium of no little importance is being conducted on secondary metals. At the morning session papers devoted to the changing aspects of the secondary metals industry are being delivered. The afternoon session is being devoted to the collection, segregation, and reclamation of the principal non-ferrous metals. Most of the important men working in this field and with the WPB are participating in the discussions.

Discussion on Boron

A symposium of decided interest during the week is being devoted to boron. The discussion is more or less informal.

The 22nd annual Institute of Metals Lecture is being delivered by V. K. Zworykin, associate director, Radio Corp. of America. His subject is "Applications of the Electron Microscope in Metallurgy."

Meetings and Expositions

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, annual meeting. New York, N. Y. February 15-18, 1943.

AMERICAN SOCIETY FOR TESTING MATERIALS, spring meeting. Buffalo, N. Y. March 1-5, 1943.

AMERICAN GAS ASSOCIATION, War Conference on Industrial and Commercial Gas. Detroit, Mich. Mar. 11-12, 1943.

AMERICAN SOCIETY OF TOOL ENGINEERS, annual meeting. Milwaukee, Wis. Mar. 25-27, 1943.

ELECTROCHEMICAL SOCIETY, spring meeting. Pittsburgh, Pa. April 7-10, 1943.

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION, spring meeting. Chicago, Ill. April 20-23, 1943.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, spring meeting. Davenport, Iowa. April 26-28, 1943.

AMERICAN FOUNDRYMEN'S ASSOCIATION, annual meeting. St. Louis, Mo. April 28-30, 1943.

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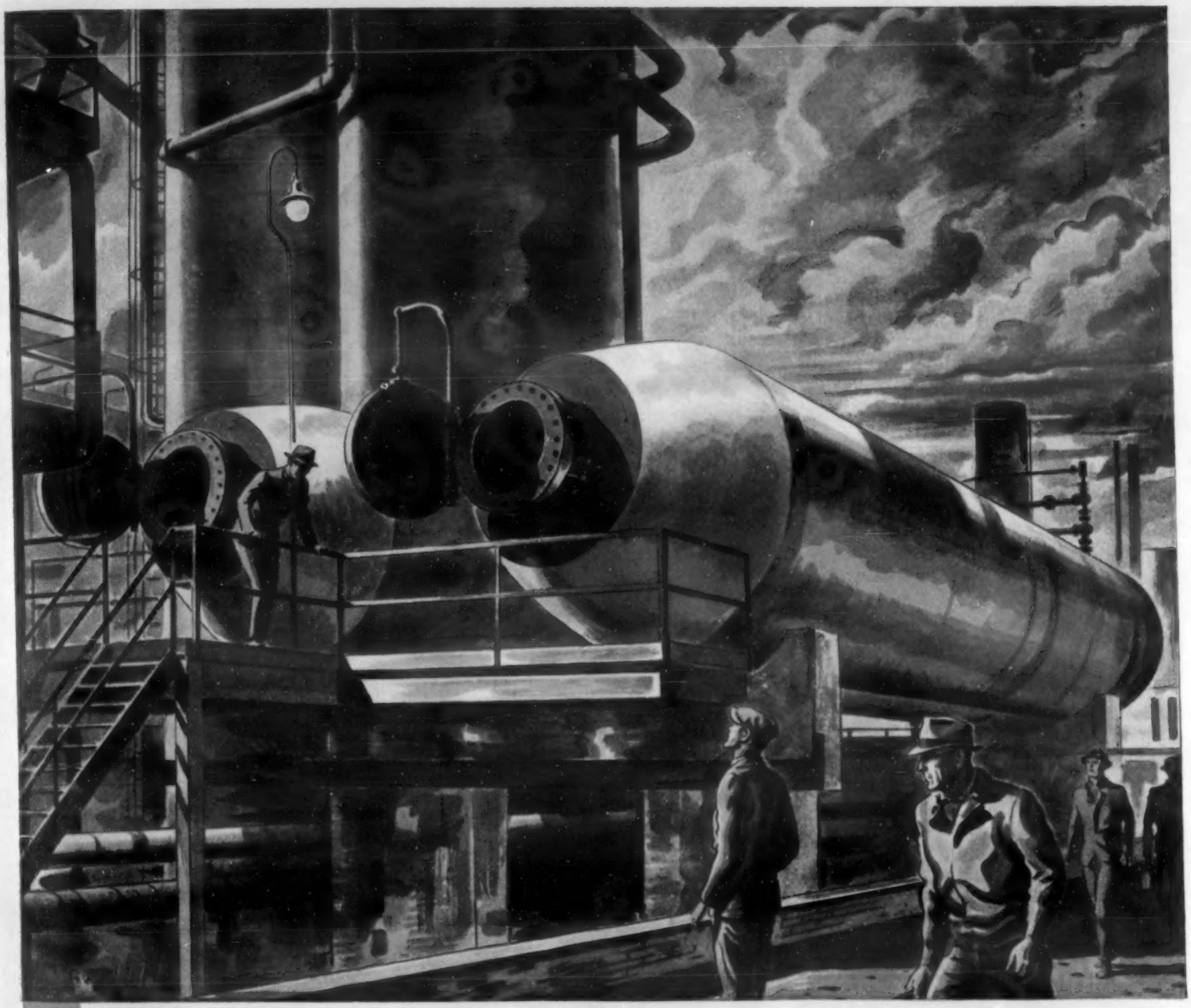

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FOR METALLURGICAL ENGINEERS

Industrial Inspection

INDUSTRIAL INSPECTION METHODS. *By Leno C. Michelon. Published by Harper & Brothers, New York, 1942. Cloth, 8¼ x 11 in., 389 pages. Price $3.50.*

Increased activity in the manufacture of war materials which must satisfy Government specifications has imposed a burden on inspection equipment and personnel. This book is one of many which are intended to facilitate in the training of instructors and prospective inspectors.

The text is divided into four parts which deal independently with dimensional control, testing for physical properties, surface inspection and inspection organization, and an appendix which contains numerous reference tables is included. Many photographs and illustrations of tools employed in inspection are presented and these, in general, are thoroughly described. Emphasis has been placed on description of tools rather than on methods of use, although sufficient information on the latter is given for those familiar with inspection methods. The theory and use of the sine bar and the geometry of screw threads and gears is particularly well handled.

The section concerned with testing for physical properties is elementary, but probably adequate for any inspector not required to actually make such tests. Each of the common and some of the less common hardness testing machines are described and a comparison is made between them. Tensile testing methods, although indicated as being important, are treated quite briefly. Perhaps some references should have been made to A.S.T.M. and government standards so that those interested could find more detailed information on the subject directly without recourse to other text books.

Non-destructive testing is covered by individual chapters on X-ray inspection, Magnaflux inspection and surface inspection. The concluding section consists of seven pages which describe the organization of an inspection department.

The subject of the text is rather broad in scope so that it was indeed difficult to treat all the various subjects with equal consideration. The final result is a text which many persons concerned with inspection will find quite helpful.

E. S. HOWARTH AND R. L TEMPLIN

Ancient Metallurgical Engineering

THE PIROTECHNIA OF VANNOCCIO BIRINGUCCIO. *Translated by C. S. Smith and M. T. Gnudi. Published by The American Institute of Mining and Metallurgical Engineers, New York, 1942. Cloth, 8 x 11 in., 476 pages. Price $5.00.*

Biringuccio was a native of Siena, Italy, 1480-1539, a contemporary of Cellini, but had little of the artistic temperament. He was a metallurgical and chemical engineer, experienced in ferrous and non-ferrous metallurgy, from the mining of the ore to the machining of the finished product, and a highly practical man. He was especially interested in firework displays on a grand scale, which accounts for the title of the book. The manufacture of gun powder, its use in warfare, and the making of guns, occupy much of the space in his book, which was first printed in 1540, 16 years before the publication of Agricola's De re Metallica which has become well known through the Hoover translation.

Biringuccio set down all he knew, and what he knew, he had found out through his own experiments and experience. He comments in caustic fashion on alchemical claims. For example, he doesn't believe the claim that there is a type of lodestone that will draw fish out of water. He was connected with the mint, held the saltpeter monopoly in Siena, cast cannon and bells and made munitions for the Florentine Republic, the Venetian Republic and the Pope.

His description of bronze casting are particularly clear. His account of the repair of a cracked bell by burning-in, applies word for word to the burning-in of a misrun bronze casting as practiced today. Copper and bronze, gold, silver, lead and tin were as important in his eyes as iron and steel, and as fully dealt with in the book.

His discussion of the design of reverberatory and other furnaces shows him to have been quite a combustion engineer. All in all, he must have been a very competent foundry superintendent.

The translation is by an expert in Italian literature, Dr. Gnudi, and by an expert metallurgist, Dr. Smith. The combination has done a remarkable job. The book is beautifully printed, the Seeley W. Mudd fund of the A.I.M.E. having made this possible. All connected with its preparation, especially Cyril Smith, may well be proud of their work.

No foundryman or metallurgist can fail to be interested in reading this account of metallurgy as it was known 400 years ago. We also liked the reference to those who "like eager hunting dogs have always journeyed throughout all the regions and shores of the world, seeking with all possible care to understand the wonders and powers of Nature."

—H. W. GILLETT.

Aircraft Processing Operations

PROCESS PRACTICES IN THE AIRCRAFT INDUSTRY. *By Frank D. Klein, Jr. Published by McGraw-Hill Book Co., Inc., New York, 1942. Cloth, 6¼ x 9¼ in., 266 pages. Price $2.75.*

One would expect that a surfeit would shortly develop in the field of books on aircraft manufacturing, but this will probably not result until we have a plethora of airplanes. For although a very large number of books on plant practice or materials for the aircraft industry have appeared in the last year, the need for almost all of them does exist, and in fact, the tremendous training requirements of what is now our No. 1 industry can hardly be satisfied by even the present crop of text and reference volumes.

The author of this book is an Army Air Forces metallurgist, and was formerly associated with some large aircraft manufacturers. This text is divided into a group of chapters on materials used in aircraft and another group on "standard" process methods. In all cases the discussions are useful and accurate, as far as they go. Unfortunately, however, the book is not at all a compendium of general practices and materials used in aircraft, but descriptions of these with which the author evidently has had direct personal experience.

This does not alter the fact that anyone following the author's exposition would most certainly obtain a very clear idea and many useful suggestions on how aircraft parts are cleaned, heat treated, finished and inspected in certain parts of the aircraft industry. Under Heat Treatment Furnaces for steel, for example, he would learn a lot about the operation and control of one particular type of furnace, atmos-

(Continued on page 462)

SAFE WAYS IN WAR PRODUCTION

NEW WORKER—Every new employee in a Bethlehem Plant wears this button. It helps to fix his attention on safety. It signals to more experienced employees that he is new to the plant, and they keep an eye on him, and do not hesitate to offer friendly guidance in case he forgets instructions and unknowingly breaks any safety regulation.

Industrial accidents, bad enough because of the human distress they cause, are also a grievous drag on production. Every day that injury lays up a worker means lowered output of the materials our armed forces are asking for.

Safety engineers know they must be more than ever on guard as pressure for production intensifies and men work against time. When war came, Bethlehem Steel Company expanded its accident-prevention program to meet the new conditions. Special efforts were addressed to the new employee to make him safety-conscious from the moment he walked into the plant. And by posters, group meetings and individual instruction, the safe way of doing his job was ground into the subconscious of new Bethlehem employee and veteran alike.

Significant are the results of a current study, showing that of all disabling accidents to Bethlehem employees less than one-third occur in the course of their work. Even with employment rolls upped by the tens of thousands and plant operations at top speed to meet the demands of the war program, the Bethlehem employee is safest, best protected against injury, during the hours he spends on the job.

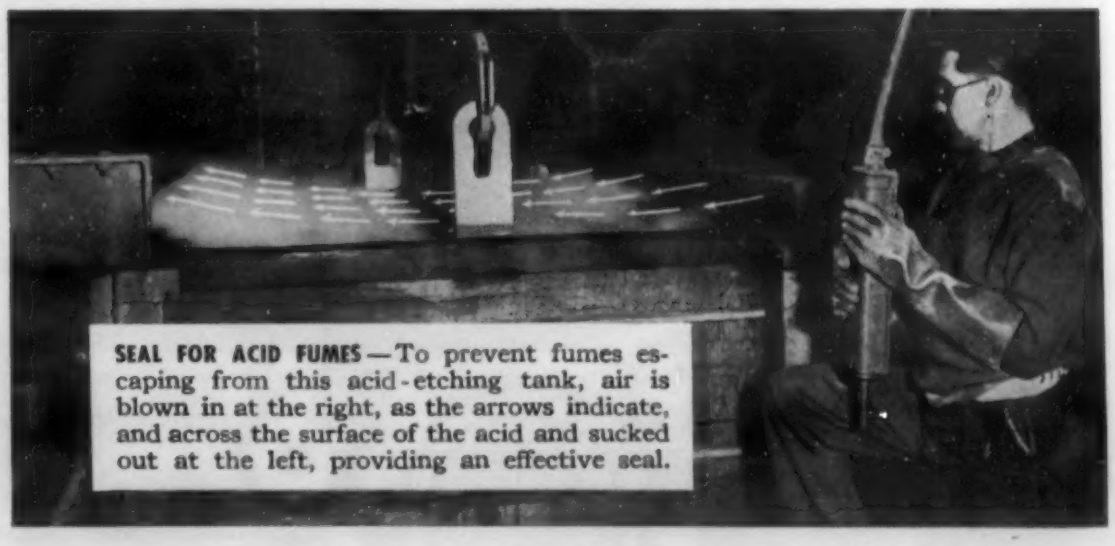
AUTOMATIC HAND GUARD—This man is operating a trimming press. If he should absent-mindedly let his hands move too near the danger zone, the two cables will automatically whisk them back to safety, before the ram of the press descends.

100% HEAT-INSULATED—Asbestos-covered hood, chrome-leather full-length apron, chrome-leather gloves, chrome-leather full-length sleeves and asbestos guard on torch handle give this worker complete protection against heat and flying sparks.

EYES DOUBLY GUARDED—Even though this grinder is equipped with a heavy glass shield, the eyes of the man who is operating it are given further protection against sparks or flying bits of abrasive by the cup goggles that he is wearing.

BETHLEHEM STEEL

Bethlehem Steel Company is actively supporting the National Safety Council in its campaign against accidents in war production, through the War Production Fund to Conserve Manpower.



SEAL FOR ACID FUMES—To prevent fumes escaping from this acid-etching tank, air is blown in at the right, as the arrows indicate, and across the surface of the acid and sucked out at the left, providing an effective seal.

(Continued from page 460)

phere, control instrument, etc., rather than obtain the expected general picture of the various steel-treating furnaces.

In other words this is a *good* book, what there is of it!

—Fred P. Peters

The Phase Rule's Originator

Willard Gibbs. By Muriel Rukeyser. Published by Doubleday, Doran & Co., Inc., Garden City, N. Y., 1942. Cloth, 6¼ x 9¼ in., 465 pages. Price $3.50.

The author of this biography is a poet, an historian, and has either assimilated considerable thermodynamics and mathematical physics, or has taken counsel from those who do know them and what can be done with them. This is an unusual combination, resulting in an unusual book. The vocabulary and much of the phrasing reflects the poet. The words are striking, yet not of Sunday Supplement flamboyance.

One article on chemical equilibria, published in the Transactions of the Connecticut Academy of Arts and Sciences in 1874 is the one that introduced what is now known as the "Gibbs phase rule" and that so overshadowed his other writings that many chemists and metallurgists may be surprised at the list of several other important, and more easily understandable, papers also published by the Connecticut Academy, upon which his professional reputation and recognition were more immediately based than on his masterpiece. The slowness with which the paper on equilibria was assimilated is often ascribed to the "obscure journal" in which it was published, whereas the Transactions of the Connecticut Academy was, for its time, one of the outstanding scientific publications and evidently had world wide circulation among the few who cared about its contents.

Gibbs based his conclusions on mathematics and abstract reasoning, not on experiment. In accomplishing things with paper and pencil rather than by experiment, with the mind rather than with things, Gibbs stands alone among physicists. Einstein works in similar fashion, but many years must pass, if it ever happens, before his results lead to the applications such as have fruited from the seeds Gibbs sowed.

Gibbs wrote in a language understood by few, and perhaps too little credit is given to the interpreters, especially those who carried out the experimental work which, by piling understandable example upon example, made it possible for the freshman to grasp something of the principles, and for the engineer and metallurgist to use the facts derived from principles, whether he grasps the principles or not.

This readable book, written with great understanding, should go far to spread an understanding of what Gibbs' work meant to the world.

—H. W. Gillett

Other New Books

New Technical and Commercial Dictionary. *Compiled by Antonio Perol Guerrero. Published by Editorial Tecnica Unida, Brooklyn, N. Y., 1942. Fabrikoid, 6½ x 9¼ in., 600 pages. Price $10.00.* This dictionary is described as the result of many years of planning. In it many new words and their meanings are listed which were not in existence a few years ago. The dictionary is compiled for the engineer and technician by a well-known Spanish engineer and an attempt is made to include all needed modern words referring to many fields of engineering. Conversion tables of weights and measures and monies are included.

Gas Welding Job Training Units. *Published by American Technical Society, Chicago, 1942. Cardboard, 8½ x 11 in., 92 pages. Price $1.25.* This gas welding manual has been produced by the staff of the Dunwoody Industrial Training Institute of Minneapolis. The plan of training and the training material have been developed, treated and improved by not only the Dunwoody Institute but also by the Smith Welding Corp. and the Commercial Gas Co., all of Minneapolis. The gas welding unit consists of 40 jobs with a job information sheet and a checkup question sheet for the first 28 jobs.

Fatigue of Metals—Some Facts for the Designing Engineer—Second Edition. *Published by The Nitralloy Corp., New York, 1942. Paper, 6¼ x 9¼ in., 88 pages.* The first edition, which came out about a year ago, has been considerably expanded by a fuller treatment of several topics and the addition of new ones. This publication has nearly double the pages of the first edition.

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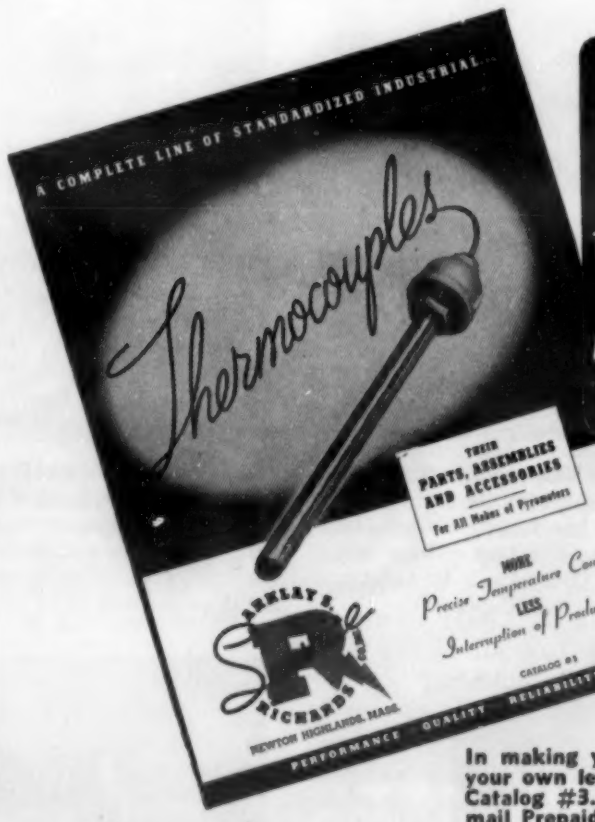

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trends

By Edwin F. Cone

Silver Coinage

A new high record for domestic silver coinage was made in 1942, the 11-month figure of 69,100,000 ounces being 16,900,000 ounces greater than the previous full year's record established in 1941. Of this 2,744,000 ounces were used in the new "silver" nickels which contain 35 Ag, 56 Cu, and 9 per cent Mn.

More Steel Ingots

Illustrative of the expansion in steel ingot output last year is the fact that the U. S. Steel Corp. subsidiaries produced approximately 30,000,000 tons of steel ingots in 1942 as compared with a little less than 29,000,000 tons in 1941 and 23,000,000 tons in 1940. — From the year-end statement of Irving S. Olds, chairman of the board.

Steel Castings

Demand for steel castings continues unabated. The latest data of the Bureau of Census show that bookings for the first 11 mos. of 1942 totaled more than 2,000,000 net tons as compared with 1,561,864 tons for all of 1941. Production to Dec. 1, 1942, exceeded 1,500,000 tons versus 1,000,316 tons for the complete year of 1941.

Rectifiers in Steel Mills

The application of rectifiers to steel mill service has surpassed all expectations. One company reports that it has installed 15 rectifiers, totaling 23,500 kw. in the past 2 yrs.

A New Tinless Bearing

Steps to conserve tin continue. Westinghouse reports that sleeve bearings of motors and generators have always contained a large quantity of tin. Babbitt metal for this purpose has been composed of 85 Sn, 10 Sb and 5 per cent Pb. Another mixture, used in much larger quantities, takes 8 Sn, 14 Sb and 78 per cent Pb. As a result the makers of babbitt have developed a tinless metal which consists of approximately 80 Pb, 16 Sb and about 4 per cent As. "Engineers have been busy adapting bearing construction and technique to the new arsenic metals. For the most part the new bearings appear to be as good as the old ones in performance and are no more difficult to make, are less expensive to build, and save tremendous quantities of tin. The new bearing is saving about 5,000 lbs. of tin per month at Westinghouse plants."

The Spectroscope As a Factory Tool

"Normally a laboratory instrument, the spectroscope is rapidly becoming a factory tool." So much alloy steel mixed with ordinary scrap steel is creeping into furnace charges and thus in a measure converting carbon steel into an alloy steel that Westinghouse engineers are subjecting every batch of metal to spectroscopic examination so as to detect the presence of alloying elements. "Some shipments of ordinary steel contain more nickel than the so-called nickel-steel alloys."

Pig Iron in 1942

Output of pig iron by American blast furnaces continues to make records. The 1942 production was a new high at 59,334,735 net tons, according to the American Iron and Steel Institute. The total with ferroalloys was 59,982,157 tons. The previous record was the 56,686,604 tons in 1941. Operating rate last year was 99.2 per cent of capacity.

Less Ferromanganese and Spiegel

Contrary to expectations the output of ferromanganese and spiegeleisen last year declined from that of 1941 — despite an increase of over 4,150,000 net tons in the pig iron and ferroalloy production. The output of ferromanganese and spiegel in 1942 was 647,422 tons — in 1941 it was 730,009 tons.

Centrifugal Castings

Unsymmetrical parts are being cast centrifugally in production by the expedient of counterbalancing the molds, according to Automotive Council for War Production. This is pointed to as enlarging the scope of the technique of centrifugal casting. An airplane landing-gear pivot is one part being produced this way. Previously it was made from steel plate by welding together 18 separate pieces, requiring 15 ft. of welding. The centrifugally cast steel part is reported to be 3 lbs. lighter than the built-up part.

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trends

By Edwin F. Cone

Record Alloy Steel in 1942

We know that the trend in the output of alloy steels in 1942 was upward but the opinion was general a year ago or more that the 1941 record would not be greatly exceeded, due to the situation in strategic metals. W. S. Tower, president of the American Iron and Steel Institute, in his year-end statement, reported that "nearly 11,400,000 tons of high-grade alloy steels were produced in 1942, about 40 per cent more than the record tonnage produced in 1941, and almost six times the 1918 output." This is a decided reversal of expectations late in 1941.

High Rate of Steel Output

A sustained period of operations of steel plant equipment has been in effect for over 2 yrs. Since September 1940, the steel plants of the United States have been operating at a rate of 90 per cent or more of capacity. In 23 of these 28 months, operations have exceeded 95 per cent of capacity. "Such a sustained period of operations at forced draft has never before been achieved."

More Steel Capacity

"By July 1, 1943, the American steel industry is expected to have facilities to produce steel at the rate of 96,000,000 net tons annually." — W. S. Tower, president, American Iron and Steel Institute.

Steel Plates

The constantly increasing demand for steel plates in 1942, largely for Liberty and for warships, resulted in an estimated output of 11,600,000 tons of plates. This is an "astounding total" for it is almost 90 per cent more than the record production in 1941. The conversion of wide strip mills to plate production was a big factor. These mills at the end of 1942 were rolling fully 45 per cent of the plates being made. This is on the authority of W. S. Tower, president of the American Iron and Steel Institute.

Electric Steel Capacity

"An important factor in increasing alloy steel production for war needs has been [in 1942] the expansion of electric furnace capacity by 150 per cent since the outbreak of war in Europe." — W. S. Tower, president, American Iron and Steel Institute, in a year-end statement.

Expansion in Steel Capacity

A realization of the gradual growth in the capacity of the American steel industry is derivable from an official statement of the president of the American Iron and Steel Institute to the effect that "since January 1940, steel producers in this country have greatly expanded their producing facilities. They have built in that period the equivalent of a new steel industry almost as big as the entire steel industry of Great Britain."

Steel Output in 1943

A prominent American economist, in making the predictions of developments in 1943, states that the output of ingots and steel for castings, which made new records in 1942, will probably do so again this year but that it is "unlikely that the increase will be less than 4 per cent or more than 6 per cent."

Lake Iron Ore

Demand for iron ore to supply increased production of pig iron has been so heavy that a new record for the 1942 season was established in shipments of iron ore from the Upper Lake region. The season's total was 92,077,000 tons which is 14.9 per cent above the previous record of 80,116,000 tons established in 1941.

Women in the Foundry

Another stronghold of men in industry is about to be conquered by women — they are going to work in the foundry. A large manufacturer of molding machines has redesigned one of its machines so that it can be operated by women.

Expansion in War Output

Typical of the trend in expansion of many companies in the output of war material, a large manufacturer of electrical equipment in the Pittsburgh district reports (December) that "at its current tonnage rate it is delivering enough material to fill 4,900 freight cars in a single month." This company has stepped up its monthly production from $34,000,000 worth of equipment in January 1942 to more than $52,000,000 in October and has added more than 1,500 new employees every month during the past year.

Aluminum Capacity and Output

The capacity of producing aluminum in the United States in 1943 is estimated at 1,050,000 net tons, according to the annual statement of the Aluminum Co. of America. This is said to be 63 per cent more than the aluminum output of the whole world in 1938. The 1942 production is placed at about 500,000 tons.

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